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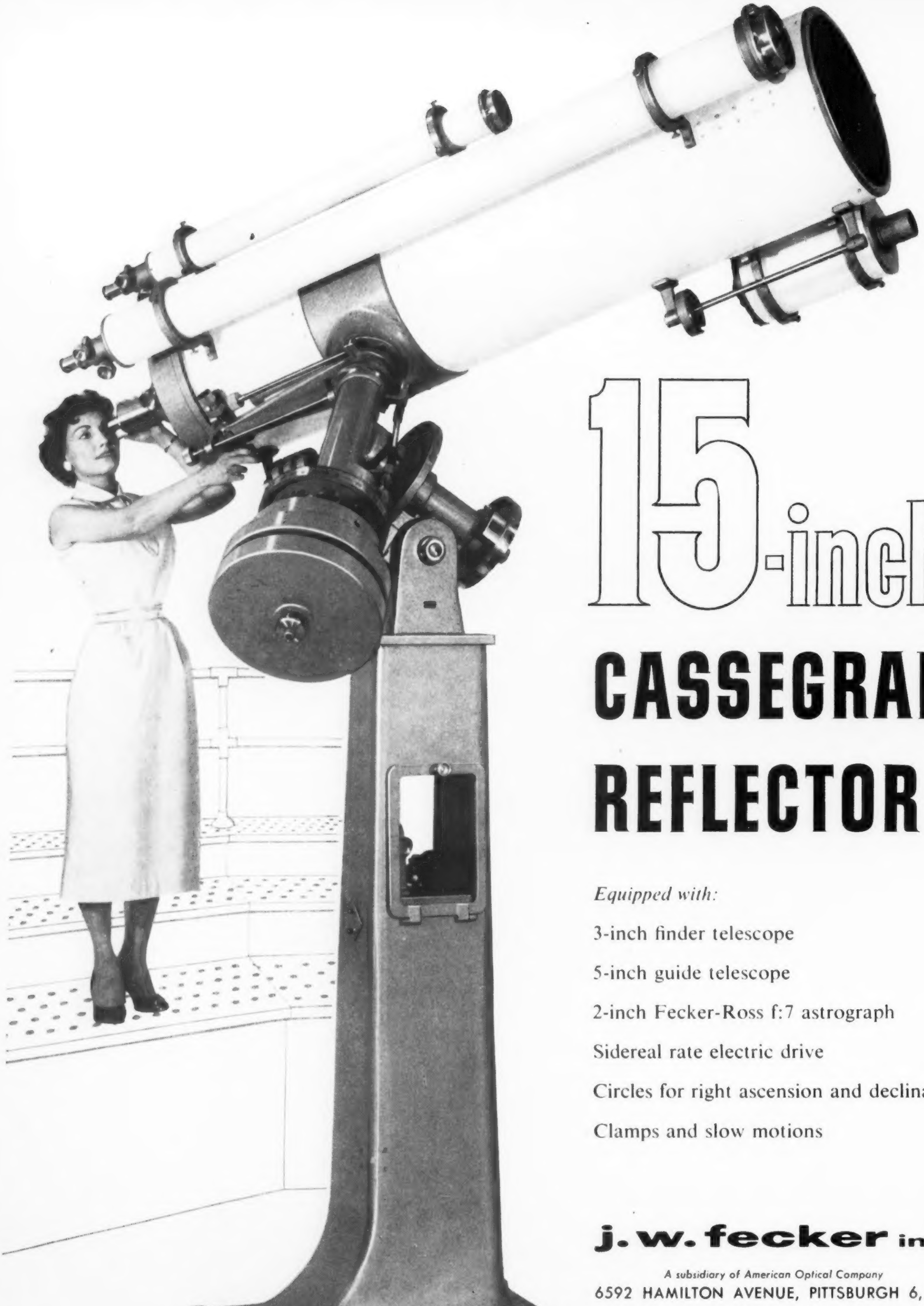
Vol. XVIII, No. 12
OCTOBER, 1959
50 cents

Henry Fitz's Optical Workshop
Convention in Denver
Australia's 210-foot Radio Telescope Project
Stellar Motions
An Amateur's Solar Observations
Stars for October



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Sky and TELESCOPE

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Vol. XVIII, No. 12 OCTOBER, 1959

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Henry Fitz's Optical Workshop

THE OPTICAL WORKSHOP of the first American telescope manufacturer, Henry Fitz, has recently been put on display in Washington, D. C., at the Smithsonian Institution's arts and industries building. The 19th-century instrument maker's shop, as pictured on the front cover of this issue, includes a foot-powered lens grinder and polisher, simple testing apparatus, and a number of telescopes under construction.

Fitz was born in 1808 at Newburyport, Massachusetts, becoming first a printer and then a locksmith. About 1835 he began to make reflecting telescopes, gaining fame a decade later for a 6-inch refractor, the first sizable instrument of this type made in America.

The workshop was in New York City, at 237 5th Street in lower Manhattan. There, during the 40's and 50's, Fitz constructed many highly successful telescopes. Among them were 12-inch refractors for the University of Michigan and Vassar College, and 13-inch instruments now at the Dudley Observatory, Albany, New York, and the Allegheny Observatory in Pittsburgh. It was with an $11\frac{1}{4}$-inch Fitz refractor that Lewis M. Rutherfurd took his historic photographs of star clusters around 1870, and Lewis Swift gained world-wide recognition for his many comet discoveries with a $4\frac{1}{2}$-inch Fitz telescope.

This self-taught American optician died on October 31, 1863, when he was about to go to Europe to procure glass blanks for a 24-inch refractor. Though well known in his day, he is now less famous than Alvan Clark and John A. Brashear, who came after him.

His son used the shop for about 20 years, and then his widow removed it to Long Island, where the equipment remained in the possession of the family until 1957. The tools on exhibit were donated to the Smithsonian Institution by Fitz's granddaughter, Louise Fitz Howell, of Southold, New York.

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Convention in Denver

Two showings of the Air Force Academy's planetarium at Colorado Springs were necessary to accommodate the 500-odd persons who took part in the field trip on August 29th. Henry M. Corrado's photograph shows the amateurs entering the planetarium, which houses a Spitz Model B projector. A dozen buses were required for the trip, some of them seen lined up in the picture below, taken by Mrs. William H. Glenn.

A RECORD NUMBER of amateur astronomers from the United States, Canada, and Cuba thronged to the first Nationwide Amateur Astronomers Convention in Denver, Colorado, August 28-31. At least 550 persons registered officially, while more than 600 were present at many of the convention's sessions.

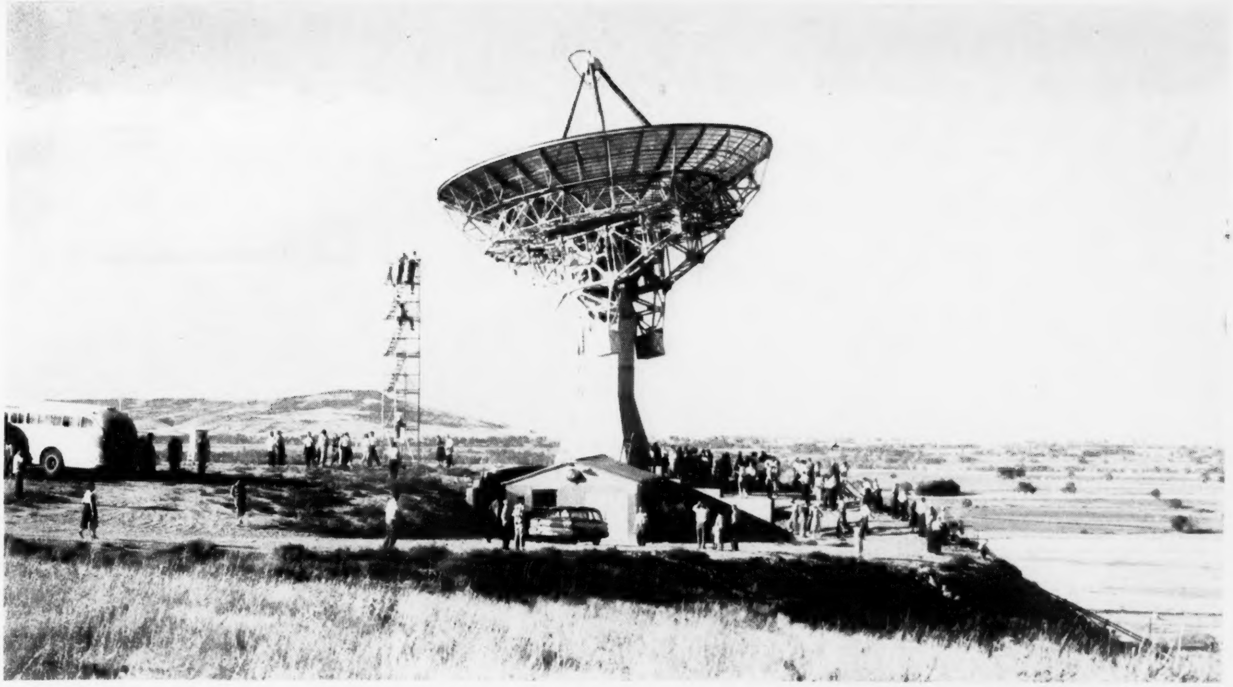
Only about 50 persons had been expected on Thursday afternoon, August 27th, so the registration committee was hard pressed when 200 arrivals lined up on the steps and in the foyer of the Student Union of the University of Denver.

The meeting opened at 10:30 Friday morning, when Dr. Albert W. Recht, director of the university's Chamberlin Observatory, welcomed the delegates. He was followed by representatives of the four convening organizations. This marked the first time they had met jointly: the Astronomical League, Western Amateur Astronomers, Association of Lunar and Planetary Observers, and American Association of Variable Star Observers.

That same morning, the host societies placed on sale a 193-page printed volume, the *Proceedings* of the convention, containing the illustrated texts of the papers, together with official reports from the Astronomical League's officers and regions. A few copies are still available at $3.50 each from the convention chairman, Ken Steinmetz, 1680 W. Hoye Pl., Denver 23, Colo.

Field trips were given a prominent

Nearly all parts of the country are represented by these delegates, who are, from left to right: Russell Maag, California, Missouri; Wilma Cherup, Pittsburgh, Pennsylvania; Arthur Smith, Jr., Miami, Florida; Jane Gann, Columbus, Ohio; George Keene, Rochester, New York; Alan McClure, Los Angeles, California; David Meisel, Fairmont, West Virginia; Leonard Abbey, Jr., Decatur, Georgia; Ernst Both, Buffalo, New York; and Walter Haas, Edinburg, Texas. This and pictures not otherwise credited are "Sky and Telescope" photographs by William E. Shawcross.



The first field trip, on August 28th, was to the National Bureau of Standards' Boulder laboratories. Here the amateurs inspect one of the 60-foot radio telescopes, the second being located a short distance beyond the right-hand side of the picture, below the edge of Table Mesa. Other groups went to the 40-foot dishes, which are elsewhere on the mesa.

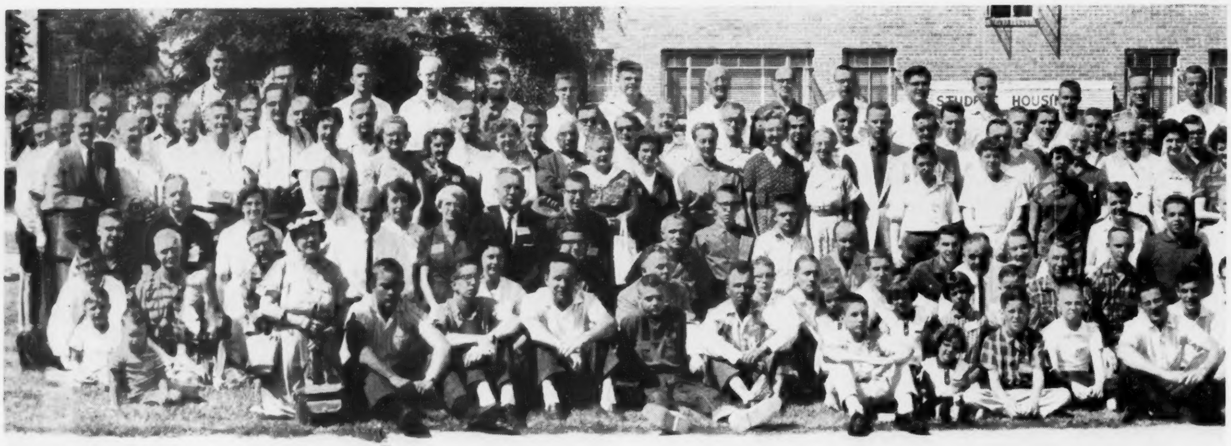
place on the program, the first one being on Friday afternoon, to the National Bureau of Standards in Boulder. The excursion to Colorado Springs the next day was equally well attended. After the tour of the Air Force's academy and planetarium, the evening was spent at the Garden of the Gods, where a chuck-wagon supper was served. There the only appreciable rainfall during the entire convention occurred, but it passed in a few minutes, permitting celestial observations to be made by those who preferred the sky to the glitter of a western folk show.

The final field trip, to the High Altitude Observatory at Climax, Colorado, took place on September 1st. This trip was completely booked — some 300 persons taking part.

Few astronomical gatherings of the past have featured two banquets. The first was on Friday evening, when about 400 people saw motion pictures of a trip to the International Astronomical Union congress in Moscow in 1958. These were taken and presented by Dr. William A. Rense, University of Colorado, and included views of the people and scenery of Tashkent and Samarkand.

At the concluding banquet, on Monday evening, awards were made by the league and the WAA, while ALPO pins were given to Elmer J. Reese and Alika K. Herring for their work in planetary and lunar observing, respectively. A roll call of states was made, 40 of the 50 being represented by the 421 diners. The official registration at the convention was: Alabama, 2; Arizona, 2; Arkansas, 2; California, 99; Colorado, 121; Connecticut, 13; Delaware, 5; District of Columbia, 1; Florida, 4; Georgia, 6; Hawaii, 1; Idaho, 4; Illinois, 32; Indiana, 2; Iowa, 8; Kansas, 12; Kentucky, 6; Louisiana, 5; Maryland, 6; Massachusetts, 7; Michigan, 11; Minnesota, 10; Missouri, 28; Nebraska, 8; Nevada, 2; New Jersey, 6;

The large number of commercial and amateur exhibits was a feature of the convention. They were set up along the sides of the large auditorium in which the sessions were held, and during intermissions the delegates enthusiastically inspected all of them. This exhibit was prepared by David Meisel to illustrate the work of the Association of Lunar and Planetary Observers. The Astronomical League also had a booth.



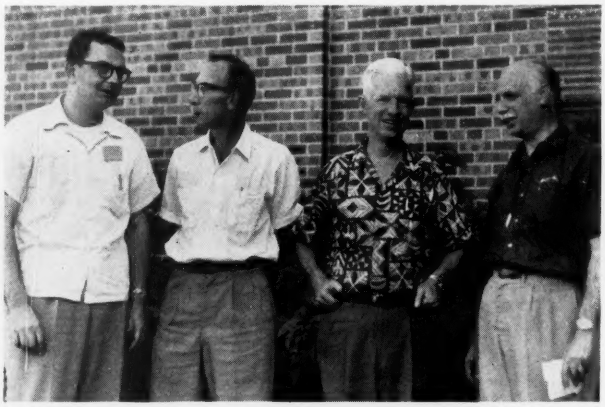
The group photograph of the Nationwide Amateur Astronomers Convention at the University of Denver, August 28-31, 1959, is presented on these pages in four parts. Photograph by Mile High Photo Co.

New Mexico, 1; New York, 18; Ohio, 26; Oklahoma, 14; Oregon, 3; Pennsylvania, 7; Tennessee, 1; Texas, 38; Utah, 2; Virginia, 1; Washington, 16; West Virginia, 7; Wisconsin, 24. Other countries: Canada, 4; Cuba, 1.

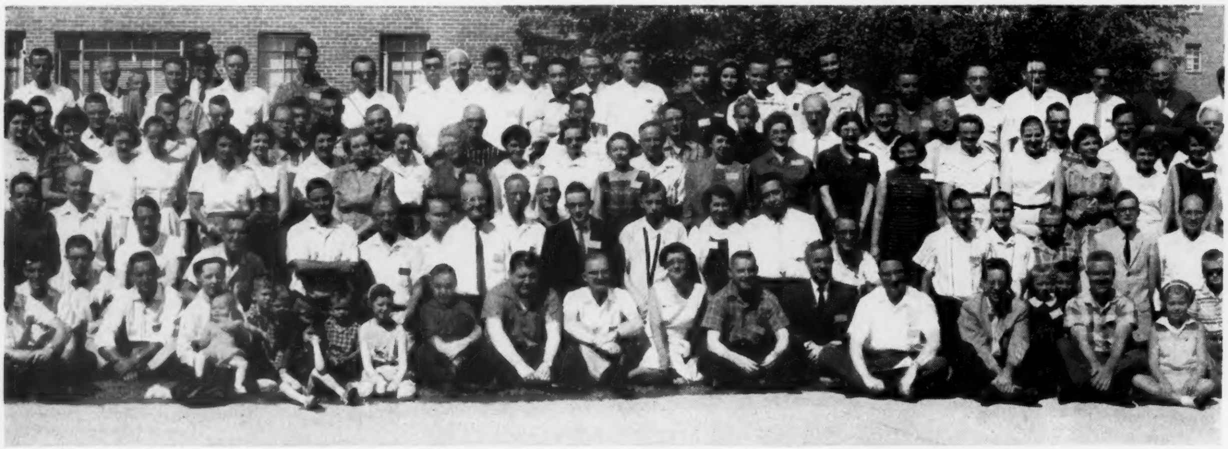
After the banquet ceremonies, Thomas A. Cragg told of some unusual experiences he and his coworkers at Mount Wilson Observatory have had. Then he presented breathtaking color motion pictures of Jupiter, Saturn, and Mars, taken with the 60-inch Mount Wilson reflector by Robert Leighton, of California Institute of Technology.

On Sunday evening, with clear skies but poor seeing, a star party was held on the Chamberlin Observatory lawn. Numerous telescopes were set up and a long line formed at the 20-inch refractor for views of prominent objects. Movies for the public were shown. This was the evening on which the discovery of Comet 1959e (see page 686) became

Thomas Cragg (center) of Inglewood, California, discusses observing problems with a group on the steps of the Student Union. Photograph by Mrs. Glenn.



Left to right: Harold Watson, Minneapolis, Minnesota; John Krewalk, Hartford, Connecticut; Clarence Custer, Stockton, California; and Armand Spitz, Yorklyn, Delaware.



The second part of the group photograph, adjoining the first part (above) on the right.

The third part of the group photograph; its continuation to the right is at the foot of this page.

Left: Grace Scholz Spitz, of Yorklyn, Delaware, former executive secretary and president of the Astronomical League, received its award for service to amateur astronomy. Photograph by Harry Brauneis.

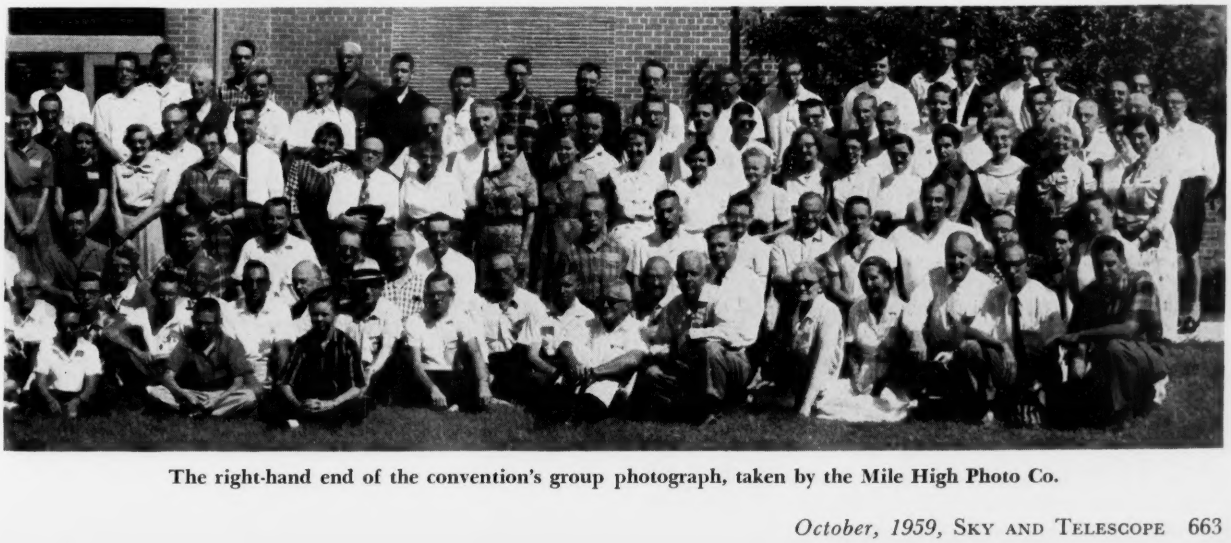
Right: Earle Linsley, of Honolulu, Hawaii, for many years director of Chabot Observatory in Oakland, California, receiving the Blair medal of the Western Amateur Astronomers. From left to right: Dr. Linsley; Walter Krumm, San Jose, California; Dr. Spitz; Chandler Holton, Atlanta, Georgia.

known, and the ALPO comet section members, led by David Meisel, detected it as a faint object in the 20-inch.

The sessions for papers adhered rather closely to the program published in the August SKY AND TELESCOPE, page 562. Walter A. Munn, Smithsonian Astrophysical Observatory, reviewed the contributions of Moonwatch observers. He pointed out that in 22 months 14 earth satellites and two artificial asteroids had been placed in orbit. There are 193 teams in the Smithsonian's observing program, 101 of them in the United States and its territories, the others in 20 foreign countries. An estimated 6,000 persons are members of these teams, about 3,400 of them in this country. Mr. Munn said further:

"An example of the value of Moonwatch is provided by the August 15, 1959, launching of a balloon-carrying satellite from Cape Canaveral, Florida, at 0:31 Universal time. The orbital inclination was 51 degrees, making the object visible along the eastern seaboard heading northeast.

"At 0:35:35, the Ft. Belvoir, Virginia, team reported three objects very close together in flight. At 0:38:22, Greensboro, North Carolina, reported three ob-



The right-hand end of the convention's group photograph, taken by the Mile High Photo Co.

Attending the Denver convention was Tim Wyngaard, a junior astronomer from Madison, Wisconsin. He will accompany American astronomers to the Canary Islands to observe the total solar eclipse on October 2nd. (See News Note on page 676.)

jects, one of them shortly after that time giving off a sparkling stream of light. A third call to Smithsonian headquarters came from New York City, where at 0:41:34 two objects were seen separated by a degree, and a third preceded them by 15 degrees. Smithsonian observers at Cambridge and Burlington, Massachusetts, saw explosions take place. Then Portland, Maine, reported only one object, as did Halifax, Nova Scotia.

"It seems that between the launching time and the first Moonwatch observation there was a premature separation of the components, followed by explosions or burning in the dense atmosphere. As soon as all reports are analyzed, it should be possible to reconstruct the exact events of the rocket's flight."

Continued strong interest among amateurs in satellite observing was indicated by the large attendance at an informal discussion group, held after the star party on Sunday evening, lasting almost until midnight.

At the business meeting, the Astronomical League re-elected its officers, headed by Chandler Holton, and chose Wilma Cherup as executive secretary for another three-year term. The Western Amateurs renamed Walter Krumm chairman, with George Perkins as representative to the Astronomical Society of the Pacific. The league will next meet in Haverford, Pennsylvania, on Labor Day weekend, 1960, while the Western Amateur Astronomers will gather at San Jose, California, in August.

ASTRONOMICAL SCRAPBOOK

LASSELL'S 4-FOOT TELESCOPE

IF YOU TRACE the development of reflecting telescopes from Sir William Herschel to the present, you will find that the direct line of descent passes not through Lord Rosse but through the English telescope maker William Lassell (1799-1880). His versatile and effective reflectors with their equatorial mountings strike a much more modern note than the unwieldy 72-inch leviathan of the Irish peer, which was slung by ropes from two great masonry towers.

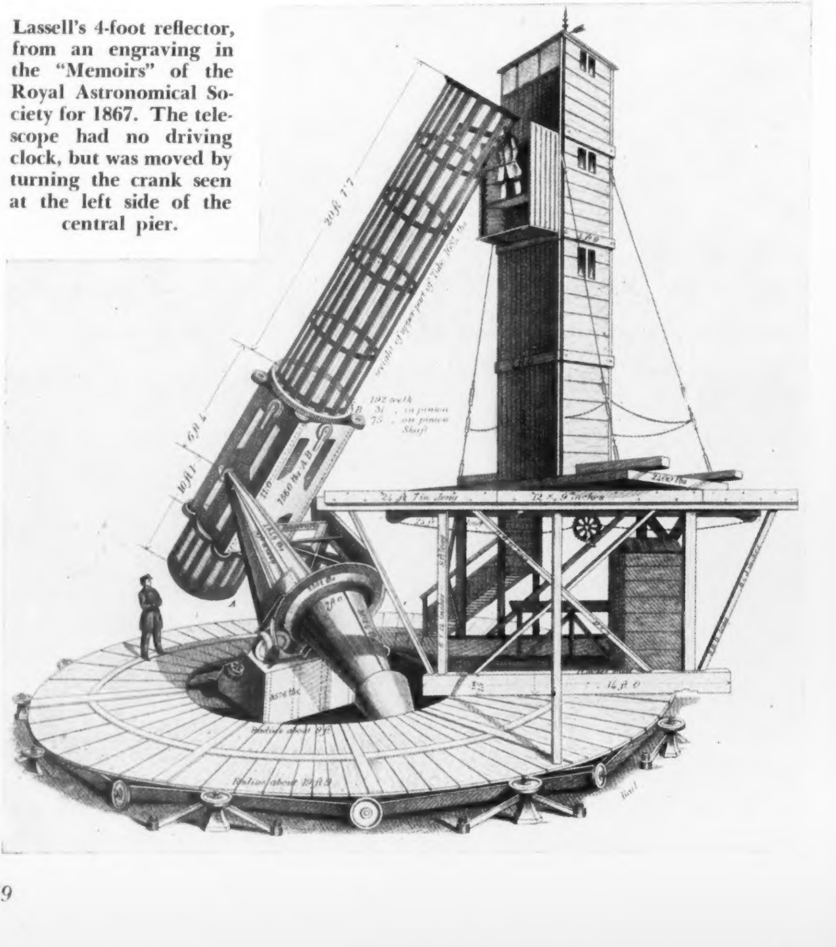
As in Herschel's case, Lassell's astronomical career was facilitated by beer. The former's marriage to the widow of a wealthy brewer gave him financial independence, while Lassell founded his own brewery in 1825, and from it secured the fortune that eventually permitted him to devote his entire time to the building and using of large telescopes.

His career as an amateur telescope maker started at the age of 21, when he made a Newtonian and a Gregorian, each of 7-inch aperture. With this experience, he erected a private observatory containing a 9-inch Newtonian. Thanks to Lassell's great mechanical ability, both his mountings and his speculum-metal mirrors were of unusual excellence for that time.

About 1844 he decided to construct a 24-inch reflector. The first step was to visit Birr Castle in Ireland, where he inspected the Rosse workshops and instruments. Work was begun with a straight-stroke grinding machine like Lord Rosse's, but soon Lassell replaced it with a curved-stroke machine of his own invention. Lassell was also fortunate to have the cooperation of James Nasmyth, another amateur astronomer, who was a gifted mechanical engineer with extensive foundry experience which was invaluable in casting large metal mirrors.

With this fine instrument, Lassell discovered Triton, the brighter satellite of Neptune, on October 10, 1846, and two years later he found Hyperion, the eighth satellite of Saturn. This object was simultaneously detected in America by W. C. Bond with the 15-inch refractor of Harvard Observatory. In 1852 the English amateur moved his 24-inch telescope to the island of Malta for the winter. Under clear Mediterranean skies he was able to observe satisfactorily all four of the satellites of Uranus known before G. Kuiper's discovery of a fifth moon, Miranda, in 1949. (There had been much confusion caused by William Herschel's erroneous belief that he had seen as many as six moons of Uranus.)

Nothing contributes more to the obso-



Lassell's 4-foot reflector, from an engraving in the "Memoirs" of the Royal Astronomical Society for 1867. The telescope had no driving clock, but was moved by turning the crank seen at the left side of the central pier.

lescence of a good amateur-built telescope than its success, which habitually leads to the desire for a still larger and more effective instrument. Lassell therefore undertook the building of the 48-inch reflector pictured here.

Erected in 1859 on the grounds of his villa near Liverpool, this telescope was an f/9.4 Newtonian with a tube 37 feet long made of flat iron bars. "There is no roof or covering over the telescope," wrote its owner, "but the observer or observers are protected by being placed in one or other of the storeys (according to the altitude of the object to be viewed) of a Tower, which affords a means of getting conveniently at the eye-piece, which, when the telescope points to the zenith, is about 39 feet from the ground.

"A staircase within the tower leads to the different storeys, which are about 4 feet 6 inches square, and afford abundant room for papers, micrometers, eye-pieces, lamps, and any other small apparatus required; beside furnishing to the observer a most grateful shelter from the dew, and occasionally from an inclement wind. During observation, however, the size of the storey in use becomes practically much larger, by the opening of the folding-doors and letting down of the platform, as shown in the engraving; the available space being then about 6 feet 9 by 4 feet 6 inches. The tower is carried round on a circular railway, and has besides, a revolution on its axis, and a radial motion to and from the telescope: so that at most altitudes and hour-angles the eye-piece is easily accessible. It has been usual, however, for the most obvious reasons, to observe within three hours of the meridian, east or west."

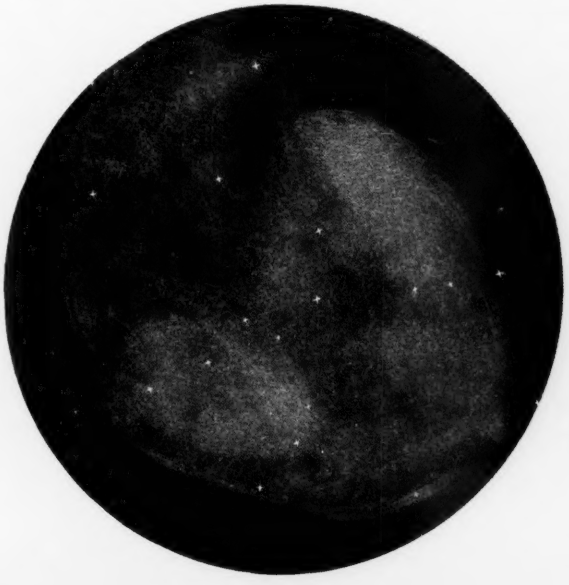
The telescope did not have a driving clock, but was moved through a gear train by an assistant turning a crank once a second, in synchronism with the beats of a clock. With this primitive arrangement, a star could be kept within the field of view for several hours, even though the moving parts of the telescope weighed about eight tons.

Nebulae were favorite objects of observation with the 48-inch reflector, the largest in England. The accompanying drawing of the Dumbbell nebula in Vulpecula was published in October, 1860, in the second of a series of circulars, the first having been devoted to the Ring nebula, M57. Lassell regarded this picture as a faithful representation of the Dumbbell, except that the brighter parts of the nebulae that gave it its name were not sufficiently prominent compared to the fainter extensions. The English amateur correctly commented that there was no indication of resolution of the nebula, and the stars in the field were totally unconnected with it, since "the sky around is quite as full of Stars as the space occupied by the Nebula."

In 1861 Lassell moved this large telescope to Malta, where during the next four years its main scientific work was done. Besides numerous measurements of faint satellites, examination was made of many of the brighter nebulae. The most important result of this survey was the recognition of spiral form in a number of galaxies. Also a catalogue of 600 previously unknown nebulae was compiled. Most of the actual observing during this second Malta expedition was not done by Lassell but by his assistant Albert Marth. An able and hardworking German astronomer who had emigrated to England, Marth has never received adequate recognition for his varied contributions to astronomy.

Lassell's return to England in 1865 marked the end of the usefulness of the 48-inch reflector, for he never re-erected it. Shortly before he died in 1880, it was sold for scrap metal. "When witnessing the breaking up of the specula," wrote Lassell, "I was not without a pang or two on hearing the heavy blows of sledge-hammers necessary to overcome the firmness of the alloy."

JOSEPH ASHBROOK



The Dumbbell nebula, Messier 27, as drawn by William Lassell with his 4-foot Newtonian reflector in 1860. The diameter of the circle is 5.6 minutes of arc, and within this area he could see 21 stars. Although Lassell does not state explicitly the magnification used in making the drawing, in his observations of other planetary nebulae he frequently used 474x, occasionally 760x, and even as much as 1,480x.

QUESTIONS...

FROM THE S+T MAILBAG

Q. Which are the five nearest stars, other than the sun, that can be seen with the naked eye?

A. Alpha Centauri, Sirius, Epsilon Eridani, 61 Cygni, and Procyon. All are visible from the United States, though the first can be seen only south of latitude +30°.

Q. Does smoking have any effect on the ability to see very faint stars?

A. Yes. Even a single cigarette will cause a slight temporary impairment of the dark adaptation of the eye.

Q. How many craters larger than one kilometer across can be seen on the visible hemisphere of the moon?

A. About 300,000. A rough value for the number of craters with diameters greater than d kilometers is given by the formula $300,000/d^2$, for d less than 200.

Q. What is speculum metal?

A. It is a highly reflecting alloy of copper, tin, and sometimes arsenic, that was used for making telescope mirrors before the discovery of a method for coating glass with silver. Speculum metal reflects less light than either silver or aluminum.

Q. What are the distances of the seven bright stars in the Big Dipper?

A. Dubhe, about 105 light-years; Merak, 78; Phecda, 90; Megrez, 63; Alioth, 68; Mizar, 88; and Alkaid, about 210. These figures are from the *Observer's Handbook* of the Royal Astronomical Society of Canada.

Q. What are Baily's beads?

A. These are the brilliant specks of light seen just before and after totality during an eclipse of the sun, when the edge of the solar photosphere shines through the valleys on the moon's limb.

Q. What are lunar domes?

A. They are low, rounded swellings on the moon's surface, with heights that are very small in proportion to their diameters. Some authorities restrict the term to smooth and perfectly symmetrical formations. Several prominent domes were described on page 91 in December, 1958.

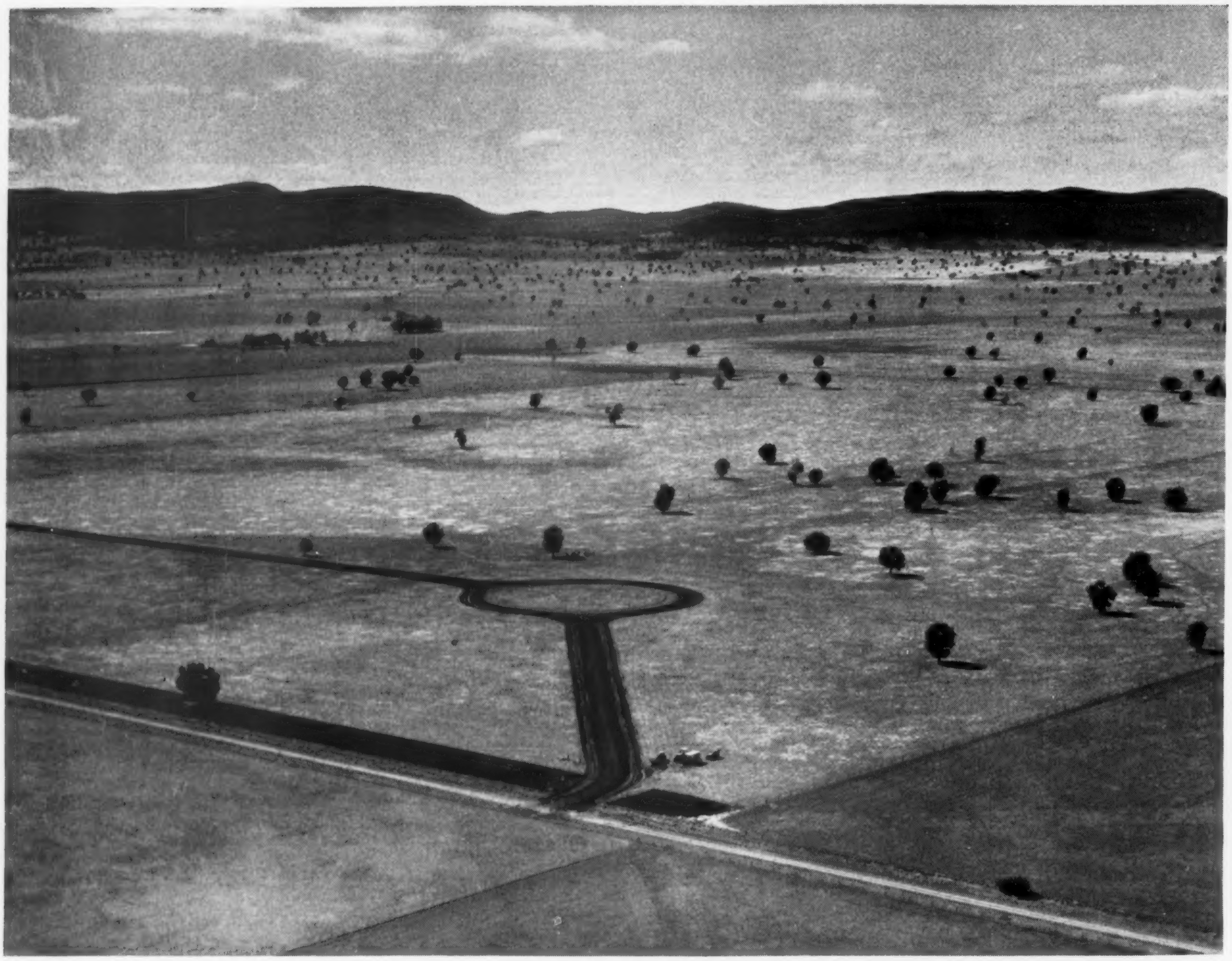
Q. Is the percentage of binaries as high among the stars of globular clusters as among those in the spiral arms of our galaxy?

A. While this question cannot be answered for binary stars in general, eclipsing variables, which are easily discoverable at great distances, seem conspicuously absent in globular clusters.

W. E. S.

CORRECTION

The last entry in the table on page 500 of the July, 1959, issue should read: "Distance in 10^5 kilometers of invisible star from center of gravity."



In this aerial view, the site of the giant radio telescope will be within the circle made by the road pattern. The surrounding land is flat for several miles, suitable for the placing of auxiliary instruments.

Australia's 210-foot Radio Telescope Project

FRANK J. KERR, *C.S.I.R.O. Radiophysics Laboratory, Sydney, Australia*

RECENTLY the primary contract to build a 210-foot steerable paraboloid for the radio astronomy group at the Radiophysics Laboratory, Sydney, Australia, was awarded to the Augsburg-Nürnberg Machine Co. in West Germany. It is expected that construction will be completed early in 1961.

The estimated cost of the radio telescope and its associated facilities is $1,700,000. Part of this sum was obtained through generous gifts from the Carnegie Corp. and the Rockefeller Foundation, and from private donors in Australia. The Australian Commonwealth Government has matched these grants on a one-to-one basis.

The new telescope will be smaller than the 250-foot dish at Jodrell Bank in England, but the surface accuracy should be considerably better. In order to allow for full operation at a wave length of 20 centimeters and reasonable performance down to 10 centimeters, the reflecting surface will be within half an inch of truly parabolic. Slight deviations from this limit, as well as from the specified pointing accuracy of one minute of arc, will be tolerated in wind speeds above 10 miles per hour.

The paraboloid is to be mounted on altitude and azimuth axes, supported on a single tower. From the base of the dish, formed by a central hub 22 feet in diameter, deep radial cantilever ribs will carry a system of spiral purlins for supporting the steel-mesh panels of the reflecting surface. Its inner 55 feet will be solid steel, however, machined to a higher degree of accuracy. With a focal length of 86 feet, the dish will be fairly shallow.

Feed antennas and associated equipment are to be carried on a three-legged support, attached to the collector at points 75 feet from its center. This tripod will be sufficiently strong to carry a cabin of substantial size at its top, to contain the critical initial stages of the equipment and to provide working space near the focal point. Scientists will reach the cabin by means of an elevator in one of the tripod's legs. With this type of support, it is a relatively simple matter to change the feed system, or to operate feeds at several wave lengths simultaneously.

The main radio equipment, together with the controls of the big dish, will be located inside the tower. Most of the other buildings on the site will be clustered half a mile from the antenna, to minimize man-made radio noise.

Why was an altitude-azimuth system chosen in place of an equatorial mount? In the early stages of the project, engineers considered these alternative designs. A study showed that the required accuracy was more difficult to obtain with an equatorial mounting, once the paraboloid's diameter exceeded 150 feet or so. For a given cost, the surface accuracy of an equatorial would be less, or, for a given accuracy, the cost would be greater. Moreover, an improved form of converter to transform equatorial to altazimuth co-ordinates was developed. With this available, the cost factor decided the issue in favor of the altazimuth system, but other considerations also support this decision.

When extreme precision of pointing is required, it may be necessary to apply calibration corrections to the position readings given by the co-ordinate dials, or to allow for the effects of refraction or thermal emission in the atmosphere. For an altazimuth system, these corrections are all simple functions of altitude only, whereas they are more complex with an equatorial mount.

Furthermore, recent developments in receiver techniques have changed slightly the relative operating merits of equatorial and altazimuth systems. The new masers or parametric amplifiers generate so little noise internally that the stray pickup of thermal noise from the ground in front of an antenna may become important. Since this pickup is likely to change as the antenna follows a source, it may sometimes be desirable to keep the dish stationary and allow the radio source to drift through the antenna beam. And were the dish to be moved in azimuth only, at constant altitude, changes in thermal ground radiation would be minimized.

Although prolonged tracking of the sky has thus become less important, an efficient and precise co-ordinate converter is an essential part of an altazimuth mount, for steering the dish to required points in the sky, and for observations where tracking will still be used. A small "master equatorial" will be set up on the top of the tower, at the center of motion of the paraboloid. This unit will control the orientation of the dish through a servo system that contains an optical link between the master equatorial and an error detector attached to the hub of the dish, as shown in the diagram.

The master equatorial carries a plane mirror, its perpendicular defining the required line of sight for the radio telescope. Once the polar axis of the master equatorial has been correctly established by means of optical sights on stars, this mirror can be directed toward any required point in the sky, and it can be driven over any desired path in equatorial co-ordinates.

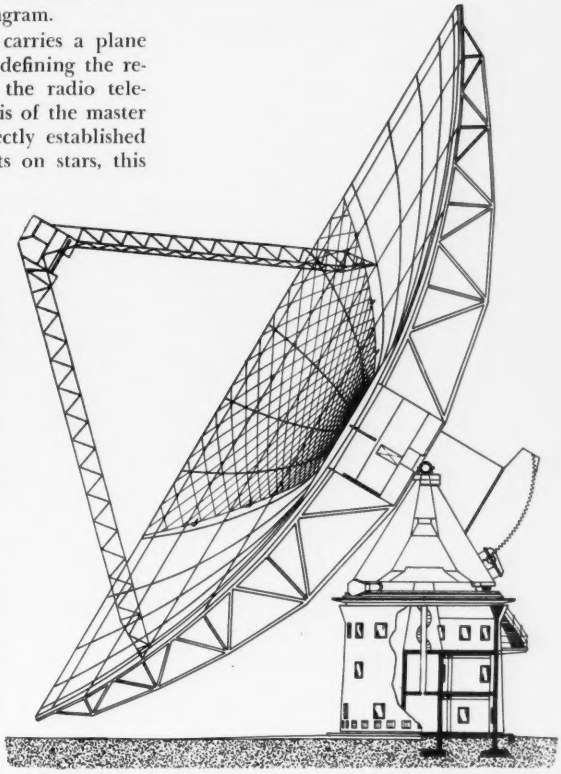
Light from a lamp attached to the dish shines on the plane mirror, and is reflected back to two photocells, one each for altitude and azimuth. In either case, a chopper arrangement senses any deviation of the beam from the center of the photocell, and a servo system keeps the collector aligned to the direction indicated by the master equatorial.

This control arrangement has two main advantages over more conventional systems in which independent co-ordinate converters are used. Accuracy is improved by eliminating intermediate steps, and the adjustments of the relatively small master equatorial unit are simple. The axes of the antenna can stray from true azimuth and altitude directions, or the main bearings may be inaccurately centered, without any ill effect on the pointing control. Even were the tower to move, through settling of the foundations, it would only be necessary to readjust the master equatorial.

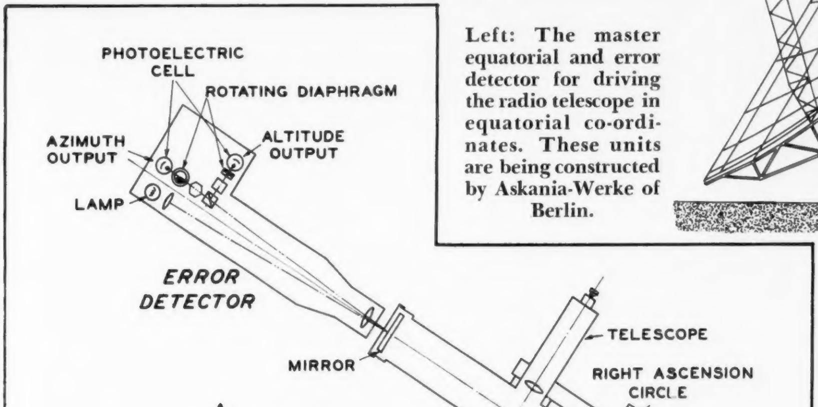
Various tracking rates and scanning patterns will be available in the control system. Fast slewing of the dish to a new position will be done with the aid of a slave model at the control desk, showing the orientation of the dish and master equatorial at any time.

The range of motion in altitude will be restricted to within 60 degrees of the zenith. By giving up the region from our horizon to an altitude of 30 degrees, the

Right: The general arrangement of the paraboloid, its mounting, and the supporting tower. The observer's cabin is at the upper left, supported on the antenna tripod. The instrument was designed by Freeman, Fox and Partners, of London. All illustrations with this article are from the Commonwealth Scientific and Industrial Research Organization.



Left: The master equatorial and error detector for driving the radio telescope in equatorial co-ordinates. These units are being constructed by Askania-Werke of Berlin.

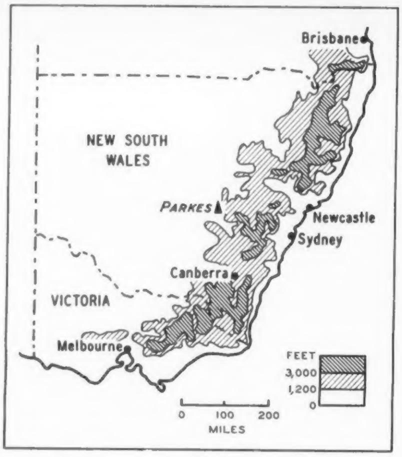


structural accuracy can be increased, because the support point is closer to the ground and less overhang is required. At a latitude of 33° south, our design provides coverage from the south celestial pole to declination +27°, which includes the whole of the southern sky and the zone of the ecliptic. The region of the sky north of +27° is well covered by northern radio observatories.

In choosing a site for a large radio telescope, the main requirement is a very low electrical noise level, to avoid interference with the very weak radiation from celestial sources. This is the radio counterpart of the need to operate an optical telescope well away from city lights. The radio observatories at Green Bank, West Virginia, and in Owens Valley, California, provide good examples of locations that were chosen for their radio quietness.

The low-noise requirement led to a decision to select a place inland, protected by mountain ranges from the industrial noise of Sydney, a city of about two million people. Other factors entering the final choice were accessibility, protection from local noise sources, and the need for enough flat land around the main antenna to permit the operation of interferometer systems or cross-type arrays.

The final choice was a valley floor surrounded by low foothills, about 200 miles west of Sydney. Only 15 miles by road from the town of Parkes, population 8,000, which has good air, road, and rail connections, the site is shielded from noise sources in that community by a series of ridges. The noise level is believed to be at least as low as that at any other radio observatory in the world.



This map of southeastern Australia shows the location of Parkes in relation to the mountains and major cities. The site is at longitude 148° 16′ east, latitude 33° 0′ south.

As wind speeds are generally low here, the radio telescope should be able to perform at its full accuracy most of the time. In continuous records covering an eight-month period, the wind speed was below 10 miles per hour 87 per cent of the time, and below 20 for 99.5 per cent. The extreme range of air temperature is 40° to 110° Fahrenheit, so there is no need to allow for snow loads on the dish.

The new radio telescope will be used mainly for studies of the 21-centimeter hydrogen line and the continuous-spectrum cosmic radiation in the wave-length range from 50 to 10 centimeters. The instrument will be particularly valuable for line and continuum studies of very distant galaxies, especially in combination with the new types of receivers that will be coming into use in the near future. The central region of the galaxy and the Magellanic Clouds offer rich fields for exploration with a southern telescope.

The Radiophysics Laboratory group has been active in most branches of radio astronomy from their start, and the head of this group, Dr. E. G. Bowen, deserves mention for instigating this new project.

Optical astronomers at Mount Stromlo Observatory already work in close cooperation with our radio astronomers, and we hope that many overseas astronomers, from the United States and other countries, will use this new instrument in attacking southern sky problems.

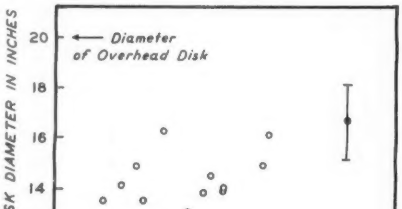
New Experiments on the Moon Illusion

ONE of the oldest known sky phenomena is the relatively large perceived size of the moon at the horizon, compared with its small appearance when seen at greater altitudes. Since the angular diameter of the moon's disk is actually somewhat smaller when it is near the horizon, the striking difference in its apparent size is called the moon illusion. The latest investigation of this phenomenon, by H. Leibowitz and T. Hartman of the University of Wisconsin's psychology department, indicates this effect in the moon's appearance is greater for young children than for adults.

A 20-inch disk was extended, parallel to the ground, from the edge of a building 85 feet high. The subjects of the experiment, 19 adults and 19 children, sat directly below this overhead disk and compared its size with that of similar objects viewed horizontally at the same distance. In every case, the disk judged equal in size to the one overhead was physically the smaller. It is evident from the graph that the youngest children underestimated most, by about 50 per cent. These results were checked by a similar indoor experiment with 10 children and 10 adults.

As is well known, the human visual system has a remarkable ability to distinguish correctly the actual size of an object, although the dimensions of the retinal image change greatly with variations in the viewing distance. This is called "size constancy." The observer subconsciously applies a "correction" so that, of two objects producing the same sized retinal image, the more distant is judged the larger. Both adults and children have considerable success in making this correction for close objects, but at large distances this ability is less, especially in the case of younger persons. Presumably, experience plays an important role.

These considerations, along with the preceding experiments, have led the Wisconsin psychologists to a possible explanation of the moon illusion. As people are more accustomed to look at objects horizontally than vertically, they make a larger size correction in the former case, though the true angular diameter of the moon is practically the same in both instances. Since children have less experience with viewing distant objects, especially directly overhead, the moon illusion is more marked for younger observers. Further details of this work have appeared in the September 4, 1959, issue of *Science,* and will be published in the *Journal* of the Optical Society of America.



The open circles are the comparisons made by 19 children, while the dot and bar indicate the adults' results.

FRANK L. GOODWIN DIES

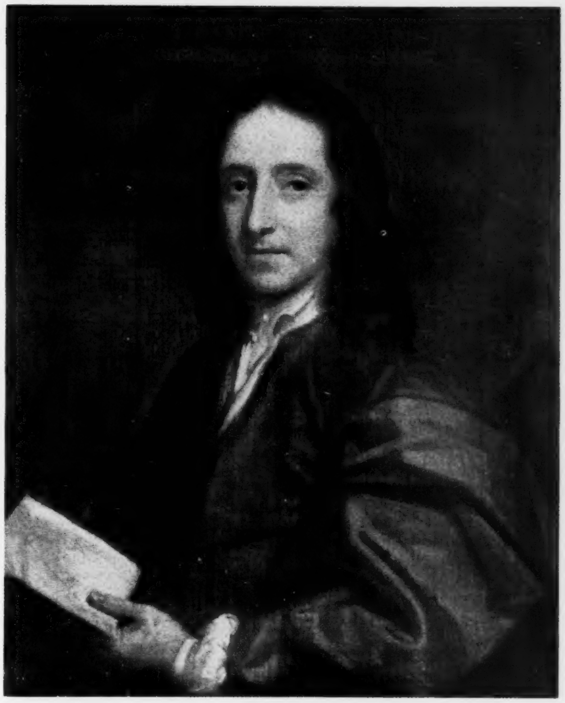
An amateur astronomy enthusiast since the age of 12, Frank L. Goodwin passed away at Chicago, Illinois, on August 26th. He was 72 years old.

By profession Mr. Goodwin was a medical and cosmetics advertising writer, and for many years headed his own agency in Chicago. In early life, he taught astronomy, physics, and inorganic chemistry, and was a personal friend of such famous professional astronomers as E. E. Barnard, E. P. Hubble, and E. B. Frost.

Mr. Goodwin was active in the Chicago Astronomical Society, serving for a time as its vice-president. He is perhaps best known for his specially designed achromatic Barlow-type lens for increasing telescope magnifications. Since 1949, Mr. Goodwin had sold thousands of these lenses to amateur and professional astronomers. He carried on voluminous correspondence on the most varied subjects with many of his customers.

Stellar Motions

Otto Struve, *National Radio Astronomy Observatory**



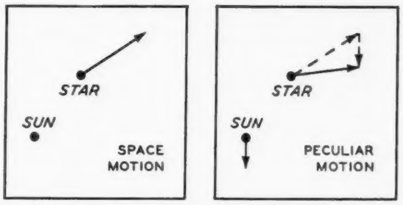
Edmond Halley (1656-1742) first proved that the stars are in relative motion. Famed also for his study of comet orbits, this versatile Englishman was the second Astronomer Royal. This portrait in the possession of the Royal Society has been reproduced from E. F. MacPike's "Correspondence and Papers of Edmond Halley" (1932).

NOT UNTIL Tycho Brahe first suggested, in 1597, that the stars lie at greatly differing distances from the sun was there reason to suspect that each star might have a motion of its own. Although Edward Bernard about 1660 made a careful comparison of the positions of the brightest stars from all ancient authorities, no evidence for stellar motions was presented before 1718. In that year Edmond Halley demonstrated that Sirius, Aldebaran, and Arcturus had moved southward since the observations of Ptolemy, Hipparchus, and Timocharis nearly two thousand years before.

Today we recognize several components of a star's motion. The apparent change in position on the celestial sphere, found by Halley, is termed *proper motion,* and is expressed in seconds of arc per year. Barnard's star, in Ophiuchus, has the largest known proper motion, 10.3 seconds of arc per year, or a lunar diameter in less than two centuries.

But proper motion is an angular rate, so in general is less for more distant stars. If we want to know how fast a star is actually moving at right angles to the line of sight, the *tangential velocity* or cross motion, we must know the distance. This velocity is not directly observable but is computed from the known proper motion and distance, and is expressed in, say, kilometers per second.

Radial velocity, motion along our line of sight to a star, is directly determined from the Doppler displacements of absorption lines present in the star's spectrum. The combination of radial velocity and tangential velocity yields the *space velocity* of a star, that is, the star's speed in the galaxy with respect to the sun.



Left: The space motion of a star is its motion relative to the sun. Right: By subtracting the sun's velocity, lower arrow, from the star's space velocity, the peculiar motion may be found.

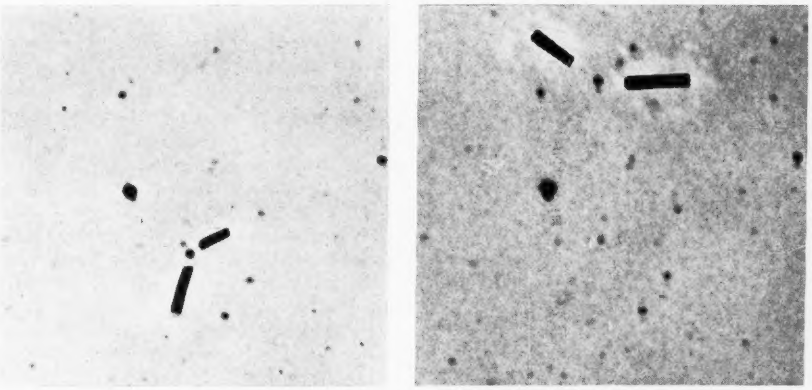
The over-all apparent motion of a star consists of two parts: the star's own *peculiar motion* and that which is due to the travel of the sun and the solar system (including ourselves as observers) in the general direction of the constellation of Hercules. With respect to the average of all nearby stars, the so-called local standard of rest, the sun moves at a speed of 20 kilometers per second. For any one star, it is a simple matter to allow for this solar motion in the observed or derived velocity components. Then the star's peculiar motion, relative to the local standard of rest, can be determined.

If we compare the peculiar motions of many stars in the sun's vicinity we find, according to Russell, Dugan, and Stewart, (*Astronomy,* Vol. II, 668, 1927), that "on the average the mean peculiar radial velocity increases by about 7 per cent for stars a magnitude fainter in absolute brightness, and is approximately doubled for a change in M of ten magnitudes."

Early in this century, it was realized that the more luminous stars are more massive than the less luminous ones. The average mass of a B-type star of absolute magnitude -3 is about five times the sun's, while that of a main-sequence star of absolute magnitude $+7$ is roughly 0.8 sun. Therefore, it was natural to suggest that the swarm of stars in the solar neighborhood might, on the average, each have the same kinetic energy. If the stars do have this property of equipartition of kinetic energy, the following relation should hold:

$$\frac{1}{2}\, m_1\, v_1^2 = \frac{1}{2}\, m_2\, v_2^2,$$

where the m's are the masses of any two



Barnard's star is a 10th-magnitude red dwarf in Ophiuchus, only six light-years distant. In consequence of its nearness and high space velocity – about 150 kilometers per second – this star has the largest known proper motion: $10\frac{1}{4}$ seconds of arc per year. Its travel between 1896 (left) and 1936 (right) is shown here, the star's images being marked by the black bars. These are negative prints from Harvard Observatory photographs.

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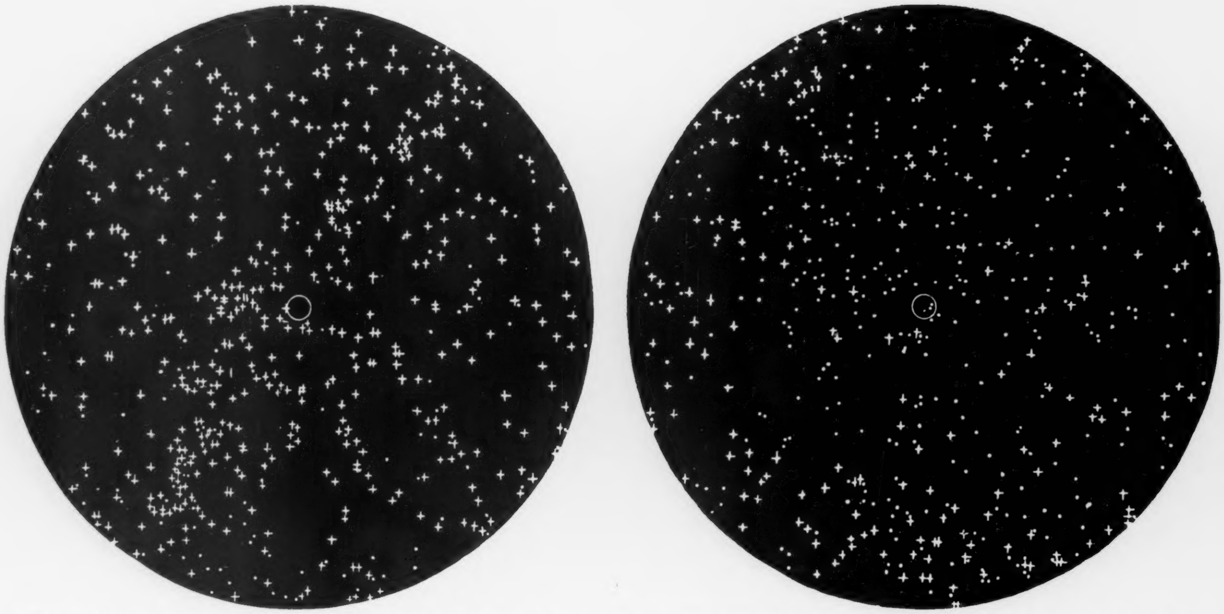
*Operated by the Associated Universities, Inc., under contract with the National Science Foundation.



The radial motions of about 1,000 stars are indicated here, dots for stars approaching us, plus signs for those receding. The former predominate in the region of the apex of the sun's way in Hercules (right-hand hemisphere), the latter toward the antapex. Reproduced from "Splendour of the Heavens."

stars, and the *v*'s their respective velocities.

If the sample masses given above are used, and if the velocity ratio is taken as two, we find the relationship is not exactly satisfied. However, 50 or even 35 years ago the discrepancy was not regarded as sufficiently serious to rule out the equipartition hypothesis.

Since then a large amount of observational and theoretical information has been accumulated that shows conclusively there is no equipartition in the Milky Way system as a whole. On the observational side, for example, we know that many of the most massive stars, those of spectral class *O*, have large space velocities. There are also several very luminous giants of late spectral type with fairly large masses whose space motions are far too great for equipartition — Arcturus is a famous case. Finally, there are intermingled with the "normal" stars near the sun many others whose velocities are very large.

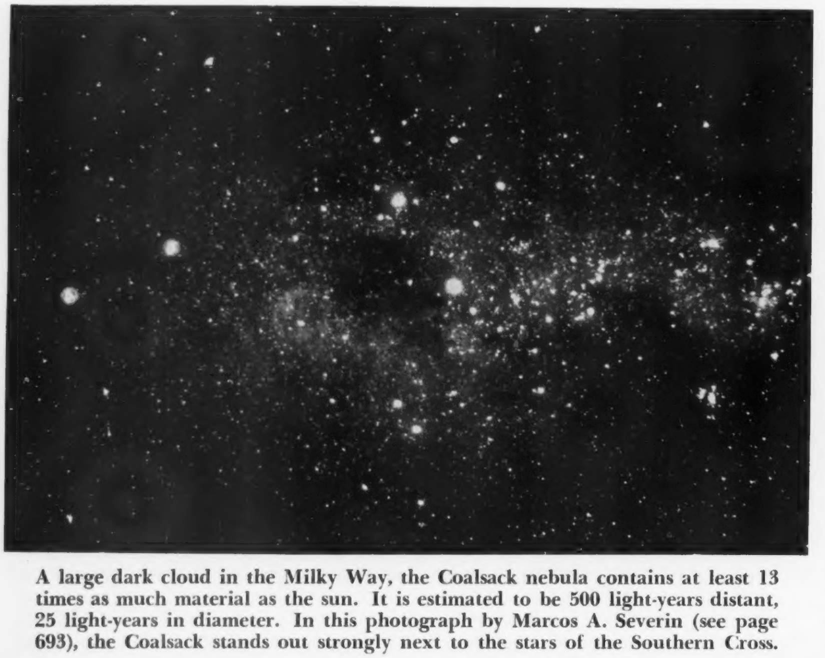
S. Chandrasekhar has shown theoretically that, since stellar collisions and close encounters are exceedingly rare, it would take some 10^{14} years for them to produce the equilibrium condition required by the equipartition of energy. As the Milky Way system is believed to have existed less than 10^{10} years, it is clear that equipartition could not have come into being through interactions among the stars since the galaxy was formed.

To gain further insight into the problem of stellar motions, let us think of the stars as molecules of a gas. In the kinetic theory of gases, these molecules are regarded as perfectly elastic spheres that are too far apart to be perceptibly influenced by mutual gravitational forces, except during the very short intervals when they are about to collide. Upon collision, the rate and direction of motion are changed.

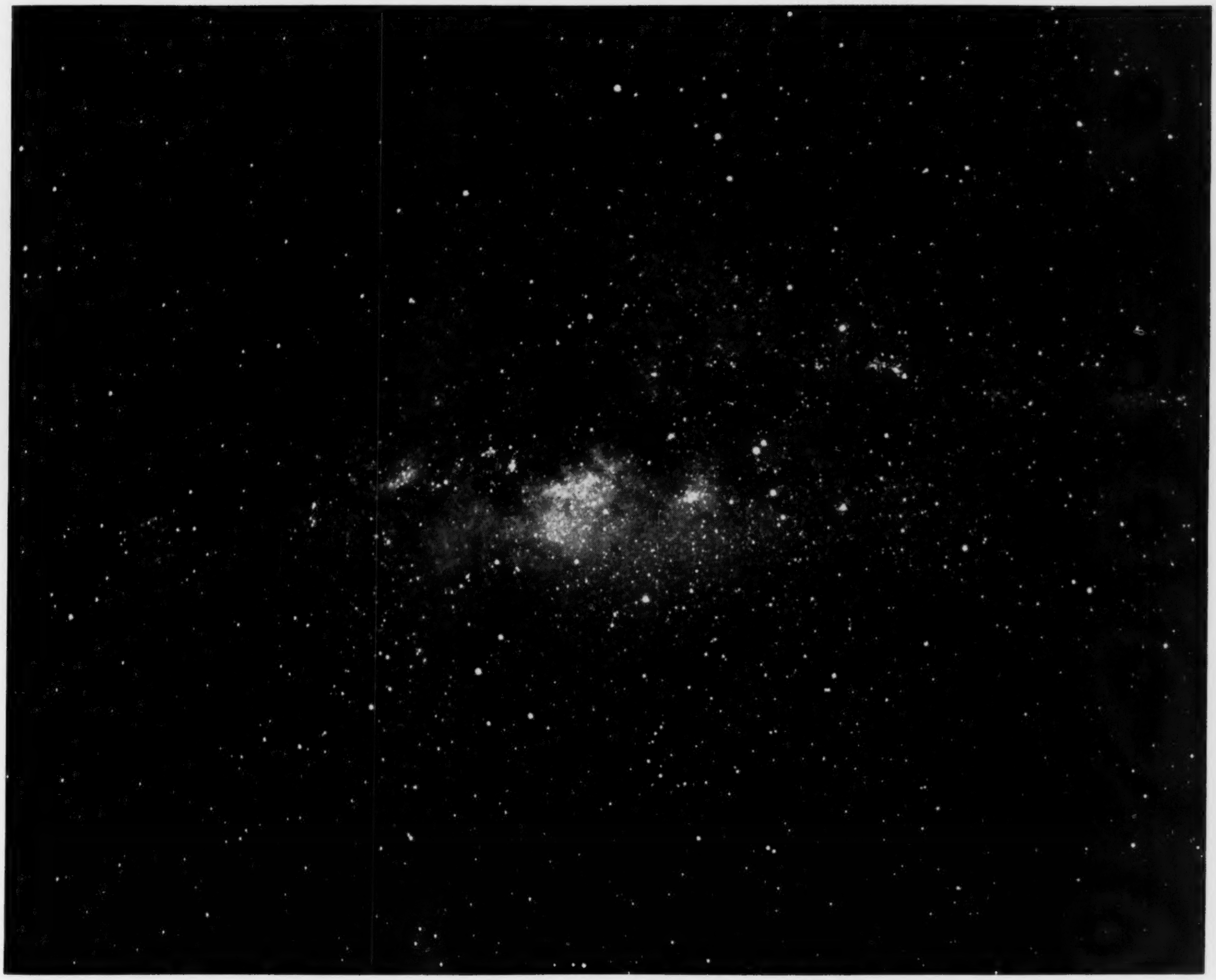
Consider first a gas consisting of molecules all of the same mass. Suppose all speeds are identical at the start, but that their directions are distributed at random. Then, each collision will tend to increase the velocity of one molecule and decrease that of the other. As the result of a very large number of collisions, an equilibrium condition will be established in the gas, in the sense that the fraction of molecules having velocities within any narrow range will always be the same. Many molecules will be moving at the average speed for the entire assemblage. Progressively fewer will move at speeds greater or less than this.

If the gas is a mixture of several kinds of molecules, heavy and light, the heavier ones will move more slowly, on the average having speeds inversely proportional to the square root of the molecular weights. This situation, under equilibrium conditions, is what we mean by the equipartition of kinetic energies.

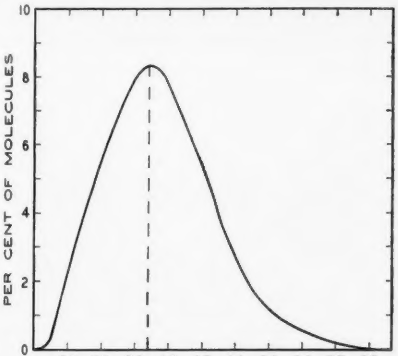
But, since any given molecule changes its velocity when it undergoes a collision, how can we be sure that the equilibrium (Maxwellian) velocity distribution will actually arise? This question was answered



A large dark cloud in the Milky Way, the Coalsack nebula contains at least 13 times as much material as the sun. It is estimated to be 500 light-years distant, 25 light-years in diameter. In this photograph by Marcos A. Severin (see page 693), the Coalsack stands out strongly next to the stars of the Southern Cross.



The study of stellar motions is essential to our understanding of the structure and evolution of the Milky Way galaxy. The galactic center region is shown here, and the Milky Way from Aquila on the left to Norma on the right, in this picture by Mr. Severin. The stars of Scorpius are in the upper right center, those of Sagittarius below center. Vast dark interstellar clouds, 1,000 square degrees in extent, overlie parts of the Milky Way in Ophiuchus, Scorpius, Serpens, and Scutum.



The distribution of velocities in a gas obeying Maxwell's law. The curve is plotted for 0.1 intervals of the velocity, with the most frequently occurring one taken as unity. Thus, about two per cent of the molecules in a gas in equilibrium will have speeds between 0.3 and 0.4 of the commonest value. Adapted from L. B. Loeb, "The Nature of a Gas," John Wiley and Sons, Inc.

by the German physicist L. Boltzmann in 1872. He was able to compute how long it would take for a Maxwellian distribution to be reached from another state. For a gas whose initial distribution of velocities is non-Maxwellian, consider the time interval during which all velocities are brought very close to the Maxwellian ones (the time required for the difference between any two velocity components to become $1/e$ or $1/2.7$ of the original difference). This *relaxation time* is given by

$$T = \eta/p,$$

where η is the viscosity and p the pressure of the gas.

For hydrogen at 0° centigrade and atmospheric pressure, the relaxation time is 10^{-10} second. This is comparable to the time taken by a hydrogen molecule to traverse the *mean free path,* which is the average distance traveled by the molecule between successive collisions with others.

The problem of the relaxation time of the Milky Way is much more complicated, and it is beyond the scope of this article to discuss the fundamental work of Chandrasekhar and his pupils. But we can make some very rough estimates from the results above.

Chandrasekhar's early work, completed before it was realized our galaxy contains many large and very massive clouds of dust and gas, gave a relaxation time of 10^{14} years, as mentioned earlier. This estimate would still be correct if the interstellar medium were of very low density and uniformly distributed throughout our galaxy. But there is considerable cloud structure, and L. Spitzer, Jr., and M. Schwarzschild have analyzed the effect of these clouds on stellar velocities.

Interstellar clouds have different sizes, masses, and velocities. The largest ones may be 100 parsecs across, each separated by perhaps 1,000 parsecs from another similar cloud. The masses may be on the order of 10^{6} suns, and the peculiar motions, determined from interstellar absorption lines, are around 10 kilometers per second.

Suppose a star is located halfway between two of these clouds. Its mean free path will thus be about 500 parsecs or 1.5×10^{16} kilometers. Assuming a stellar velocity of 20 kilometers per second, we find, as a first crude approximation, that the time of relaxation is 3×10^{7} years. A more complicated analysis increases this value to 10^{8} or even 10^{9} years, but it is still small enough to suggest that during the lifetimes of stars there has been some approach toward equipartition, though not enough time has elapsed to establish a true Maxwellian velocity distribution.

However, the objects we are dealing with here are not identical to the molecules in a gas. The masses of the clouds are so great that gravitational effects cannot be neglected, and we cannot consider the clouds to be elastic spheres. If they were elastic, their large masses and motions of about 10 kilometers per second would ultimately produce extremely high stellar speeds — far in excess of what is actually observed.

How do the velocities of stars change as they grow older, and what is the final velocity distribution? The answers to these questions depend on both the effects of collisions with clouds and the consequences of galactic rotation.

According to Spitzer and Schwarzschild, who take into account the fact that the galaxy does not rotate as a rigid body in its outer regions, the velocity v of a star at t years after its birth within a cloud should be

$$v = v_0[1 + t/(2 \times 10^{8})]^{1/2}.$$

Here v_0, the initial motion of the star, is essentially the turbulent velocity of the eddy in the nebula that produced the star plus the velocity of the cloud in which it was formed.

In an important paper presented at the ninth astrophysical symposium in Liége last July, S. von Hoerner adopted a value of 10 kilometers per second for v_0. His calculations show a steady increase in the average velocities, ranging from 12 kilometers per second for stars 200 million years old to 30 kilometers per second for those five billion years old. These computed values are represented in the diagram by the dashed line.

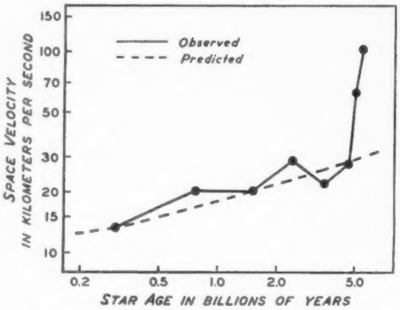
The plotted observed velocities were taken from a recent catalogue by W. Gliese for 78 stars within 20 parsecs of the sun. These are the only ones for which very accurate space motions have been determined. Von Hoerner divided these stars into eight groups, each being assigned an age equal to half its maximum possible value as inferred from current theories of stellar origin and evolution.

Agreement with the computed values is excellent up to and including the 4.6×10^{9} years age group. But as the graph shows, the oldest groups have much larger velocities than are predicted by the Spitzer-Schwarzschild theory.

Von Hoerner concludes that the youngest stars in his list still have essentially the same velocities as they possessed when they were merely tenuous condensations inside a gaseous nebula. With advancing age, the velocities tend toward a Maxwellian distribution. But the oldest stars must have had huge motions at the time of their formation. As von Hoerner says, "It seems reasonable to assume that the gas of the galaxy originally had a very high turbulence, comparable to its velocity of rotation (about 250 kilometers per second), which is still present in the velocities of the globular clusters and the halo stars — which must have been formed at a very early stage. If the diameter and the mass of the galaxy have not changed greatly since then, hydrodynamical theory predicts a time scale for the decay of the original turbulence of the order of the present mean period of galactic rotation (about 200 million years). After an interval of about one billion (10^{9}) years the initial turbulence must have decayed completely," leaving only a small permanent amount in the gaseous medium to be maintained indefinitely by radiation pressure of young, hot stars, and by the differential galactic rotation.

In other words, the oldest stars, those above about 5×10^{9} years, were formed before the original turbulence had decayed. They retain at least part of the violent chaotic motions of gases in our primitive amorphous galaxy. All the younger stars, those formed a billion years after the first ones appeared in the Milky Way, had essentially similar initial velocities of about 10 kilometers per second, identical with those presently observed for gaseous nebulae. Since the initial velocities of all stars born after the first billion years of the life of our galaxy were approximately the same, von Hoerner argues that stellar mass plays no role in the velocity distribution.

Another important cosmological conclusion drawn by von Hoerner concerns the rate of star formation in the galaxy. In previous discussions of this problem, it has usually been assumed that the space density of stars, the number per unit volume, depends only upon the rate of formation. This has led to the result that this rate has probably been constant throughout the lifetime of the galaxy. But von Hoerner points out that in his theory all stars, except those formed during the first billion years, were created in a very thin layer. The fact that we now observe many stars at great distances from the central plane of our galaxy is partially explained by increases of stellar kinetic energies as a result of the Spitzer-Schwarzschild mechanism. Hence, von Hoerner concludes that the rate of star formation at the beginning was 10 times faster than at present. One half of all presently observed stars must have been formed during those first billion years.



The Spitzer-Schwarzschild theory of age changes in stellar velocities is compared with observational results in this diagram by S. von Hoerner. The oldest stars are moving more rapidly than the theory predicts.

OCCULTATIONS OF REGULUS BY VENUS

The passage of Venus in front of Regulus on July 7th this year was a phenomenon so rare that it is often stated that no previous occurrence has been recorded. One report does exist, however, of a naked-eye observation in A.D. 885, probably at Bagdad. The Arab astronomer Ibn Jounis tells that on September 9th of that year Regulus appeared to be occulted by Venus one hour before sunrise.

In 1874, the English astronomer J. R. Hind calculated the position of Venus relative to the star for the time of this old observation, using Leverrier's tables of the planet. Hind found that only a very close appulse had taken place, the least separation of the two bodies having been 1.7 minutes of arc. To a naked-eye watcher, however, the star would have been lost in the planet's glare, simulating an occultation.

NORTH-SOUTH AURORA CORRELATION

One finding, from intensive studies of the aurora carried out at Cornell University by C. W. Gartlein, is that on any night an aurora is seen in the Northern Hemisphere one will be seen in the Southern, weather conditions permitting. The two auroras will not necessarily look alike.

Since whenever conditions are favorable in the auroral zone in one hemisphere the midnight sun will be shining in the other, it was necessary to select data from lower geomagnetic latitudes. He used observations secured at Ellsworth in Antarctica and in the United States. From experience gained in plotting maps for thousands of auroras, it was possible to estimate the distribution of displays even when only a few observations were available.

In his *News Letter* No. 23, Dr. Gartlein writes: "It appears that the U. S. will report an aurora on any clear night hour that Ellsworth reports one. The forms are not necessarily the same in both places, nor does the Ellsworth aurora always appear to be ahead of or behind the U. S."

OBSERVING THE SATELLITES

The "Paddle-Wheel" Satellite

On the morning of August 7th, at 14:24:20 Universal time, a 90-foot, 105,000-pound Thor-Able III rocket roared aloft from Cape Canaveral to place Explorer VI – the "paddle-wheel" satellite – in orbit.

During each revolution 1959δ2 comes to within 153 miles of the earth, gaining a top speed of 23,028 miles per hour, and then moves outward to apogee at 26,397 miles, slowing to 3,122 miles per hour. This highly elongated orbit is well suited to the complex mission of surveying the physical environment in a vast cross section of space that reaches one-ninth of the way to the moon.

More than 50 scientific and industrial groups collaborated under the technical direction of Space Technology Laboratories, Inc., in developing this complex satellite for the National Aeronautics and Space Administration. Over 100,000 individual components were built into the 142-pound payload.

Most of these are housed in a thin (1/16-inch) black aluminum shell, about 26 inches in diameter, 29 inches deep, and slightly flattened on the bottom. Four aluminum arms that carry 20-inch square vanes jut out nearly three feet from the waist section of this container.

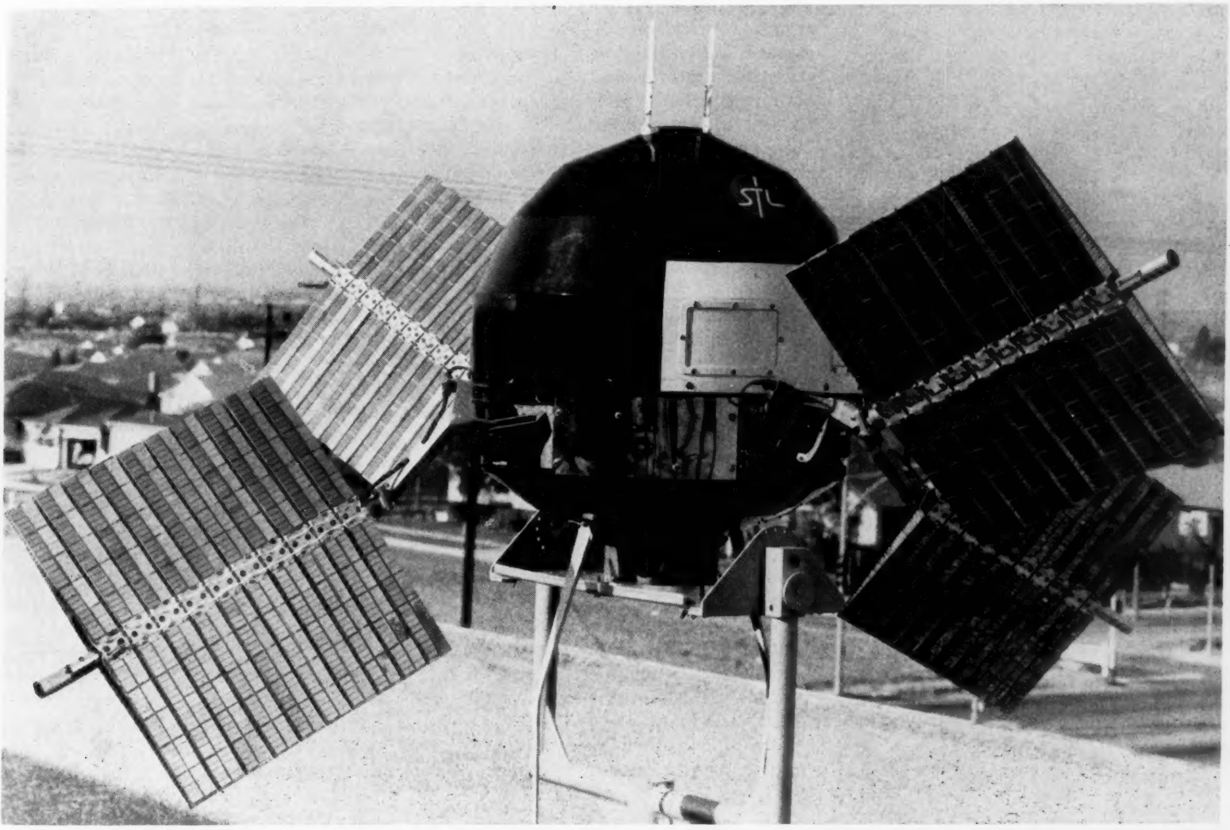
Each vane, consisting of tapered sections of honeycomb plastic, supports cells on both sides for converting sunlight into electrical energy. In all, there are 8,000 silicon-junction cells, each capable of producing, when fully illuminated, about 7½ milliwatts of electrical energy. Glass filters block harmful ultraviolet radiation, and the energy produced is stored in nickel-cadmium batteries. Maximum utilization of sunlight is assured by the satellite's rapid rotation at about three revolutions per second and by the tilt of the paddles, though only a fraction of the cells are fully illuminated at any one time. The entire 30-pound power-supply system is a prototype of those to be used for future space missions, and seems to be operating as planned.

Probes of interplanetary space are virtually useless unless radio contact can be maintained. Several of the experiments in Explorer VI are designed to provide fundamental data on problems of radio propagation. One receiver monitors the very-low-frequency signals from the Navy transmitter, NSS, at Annapolis, Maryland, and provides data on the dispersive properties of the atmosphere at the frequency of 15.5 kilocycles.

In addition, three transmitters included in the payload measure the electron density of the medium between the satellite and receivers at Kalae, Hawaii. This analysis involves a comparison of the effect of electrons on the Doppler shift at two widely separated frequencies. The Hawaiian station is also measuring Faraday rotation of the plane of polarization, which depends on the total ionization along the propagation path. At the National Bureau of Standards laboratory in Boulder, Colorado, amplitude and phase fluctuations in the satellite's signals caused by changes in the ionosphere are being studied.

Three separate sets of instruments aboard the paddle-wheel satellite are devoted to investigations of the Van Allen belts of cosmic radiation. Previous information on the outermost of these has been based on rather sketchy returns from probes making at most two passages, whereas the new vehicle crosses through the belts twice in each revolution.

High-energy particles are counted by a set of six lead-shielded, gas-filled cylinders arranged concentrically around a seventh. Some particles may penetrate as many as three chambers. A medium-energy experiment utilizes a gas-filled ion chamber and a Geiger counter, while the low-energy part of the cosmic ray spectrum is monitored by a scintillometer. Taken together, these units provide a very comprehensive analysis of the radia-



Explorer VI, with its vanes fully extended. Each side of the paddles carries 1,000 solar cells, in groups of 100, manufactured by Hoffman Electronics, Inc. This energy-conversion system is expected to function throughout the satellite's lifetime.

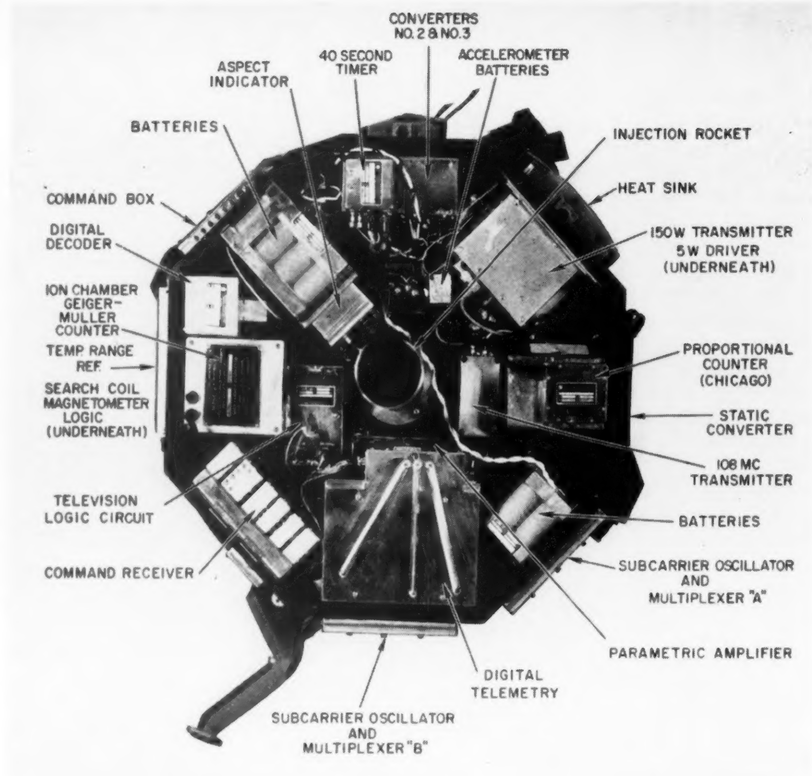
tion belts that constitute the greatest known hazard to manned spaceflight.

The properties of the earth's magnetic field are important for an understanding of the cosmic ray results. A search-coil magnetometer for measuring the strength and direction of this field, and a flux-gate device for determining more exactly the component that is parallel to the spin axis of the satellite, are included in the instrumentation. But we must know the orientation of the spin axis to interpret these results. Therefore, the phase relationship between the magnetometer and a photoelectric sun scanner is being monitored.

The frequency of encounters with micrometeorites and the momenta of these objects are observed with a pair of microphones that detect impacts on certain areas of the satellite's skin.

In an experiment that has future applications, the temperature of a portion of the satellite's exterior can be controlled by the operation of a movable propeller-shaped vane that alters the radiation characteristics. Temperature readings from several parts of Explorer VI indicate it is operating well within the designed range of 25° to 115°F.

A small facsimile unit, with a mirror that focuses an image on a photocell, is designed to provide pictures of limited resolution of the earth and its clouds. The data gathered from this great variety of observations are sent to the earth in essentially two different ways. Two one-watt transmitters operate continuously at 108.06 and 108.09 megacycles, sending information in analogue form. A third transmitter, broadcasting at an undisclosed ultra-high frequency, is operated intermittently at 40 watts for about 90 minutes out of every six hours, since the solar batteries cannot provide sufficient energy for continuous operation at this power.


CONVERTERS
NO. 2 & NO. 3
ASPECT INDICATOR
40 SECOND TIMER
ACCELEROMETER BATTERIES
BATTERIES
INJECTION ROCKET
COMMAND BOX
HEAT SINK
DIGITAL DECODER
150W TRANSMITTER
5W DRIVER
(UNDERNEATH)
ION CHAMBER
GEIGER-MULLER COUNTER
TEMP RANGE REF
SEARCH COIL MAGNETOMETER LOGIC
(UNDERNEATH)
PROPORTIONAL COUNTER
(CHICAGO)
STATIC CONVERTER
108 MC TRANSMITTER
TELEVISION LOGIC CIRCUIT
BATTERIES
COMMAND RECEIVER
SUBCARRIER OSCILLATOR AND MULTIPLEXER "A"
PARAMETRIC AMPLIFIER
DIGITAL TELEMETRY
SUBCARRIER OSCILLATOR AND MULTIPLEXER "B"

The tightly packed instrument array in Pioneer VI's 142-pound payload. All illustrations here are official U. S. Air Force photographs.

This third unit furnishes experimental data in digital form, by means of a lightweight "telebit" computer, which tallies and stores the data for later rapid transmission. Thirty different operations of the satellite, including the activating of this transmitter, are controlled by command signals from ground stations, principally located at Cape Canaveral, Florida; Millstone Hill, Massachusetts; Singapore, Malaya; Jodrell Bank, England; and those already mentioned in Colorado and Hawaii.

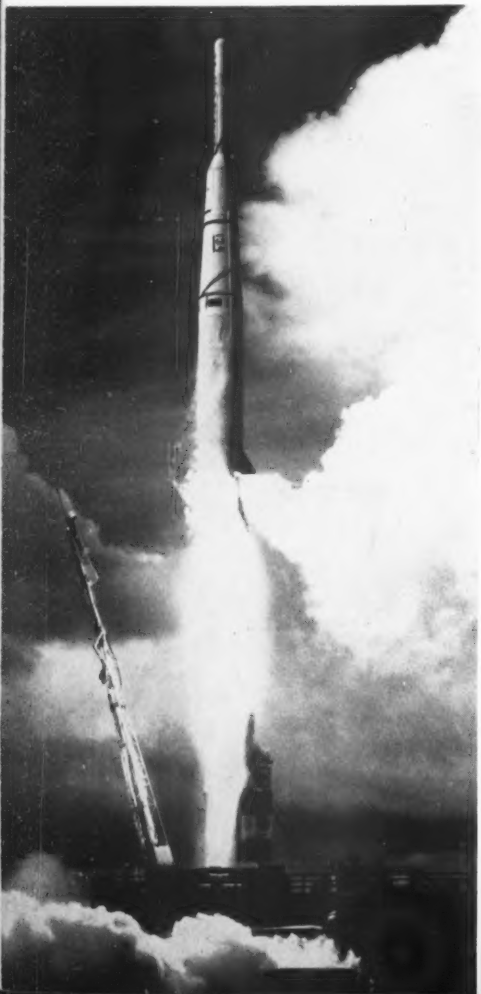
The 50-ton, liquid-fueled Air Force Thor IRBM, which was modified for placing Explorer VI aloft, developed 150,000 pounds of thrust for about 160 seconds. Next, the liquid-fueled, two-ton Able vehicle (a modified Vanguard second stage) developed about 7,500 pounds of thrust during some 100 seconds. This was the first time a Thor-Able vehicle placed a satellite in orbit.

When second-stage burnout occurred, eight spin rockets were fired to stabilize the final stage and payload. Then the plastic nose fairing was jettisoned, allowing the four vanes, which were previously folded under the spheroidal body, to spring into position.

A 500-pound, solid-fueled Allegany Ballistic Laboratory rocket, developing about 3,000 pounds of thrust in 40 seconds, was used for the third stage. After burnout, springs separated the paddle wheel from the empty rocket casing. Painted white, the latter is brighter than the instrument package, unless the sun happens to glance specularly from one of the vanes. Accordingly, the rocket is designated 1959δ1. It seems to have an orbit similar to Explorer VI.

The primary system for tracking this new satellite employs the Doppler shift of signals transmitted from the ground and rebroadcast by the satellite. For this purpose, several large radio telescopes, including that at Jodrell Bank, have been modified for "multiplex" operation.

Baker-Nunn photographs of the rocket were first obtained at Arequipa, Peru, and Johannesburg, South Africa. The tracking camera at Woomera, Australia, took several photographs of 1959δ2 at ranges up to 12,000 miles, four times farther than for any earlier satellite.



The great Thor-Able III begins its climb to place the Explorer VI satellite into orbit around the earth.

According to the NASA computing center, the anomalistic period of Explorer VI amounted to 12 hours and 46.43 minutes on August 18th. The orbital plane is inclined 47.1 degrees to the equator, and the eccentricity is 0.7612. Because of the tremendous change in speed between perigee and apogee, the satellite's motion with respect to the stellar background is unusual. Sometimes the apparent motion is eastward. However, when the satellite approaches apogee, its eastward motion is slower than that of the earth rotating beneath it, and subsatellite points on the earth's surface progress westward.

Due to its great distance at apogee, Explorer VI is perturbed considerably by the moon. Calculations by Y. Kozai and C. Whitney at the Smithsonian Astrophysical Observatory show that periodic lunar perturbations are now lowering the perigee height. The effect of air drag is thereby greatly increased, reducing the satellite's lifetime to two years — only 1/10 of what it would be in the absence of the moon. However, a small "kick" rocket, not yet fired, might be activated to raise perigee and prolong the paddle wheel's life.

PROJECT TEPEE

SEVERAL variations of the radar principle are being employed continuously for the detection and tracking of artificial satellites. Features of one system that can detect launchings taking place halfway around the world have recently been revealed by the Office of Naval Research.

Ordinary radar is effective only along the line of sight, but pulses of much lower frequency, in the 10- to 20-megacycle range, can be bounced back and forth between the ionosphere and the earth's surface. Thus, these signals may travel far beyond the transmitter's horizon. At each reflection a portion of the incident energy is scattered; some finds its way back to a sensitive receiver near the transmitter.

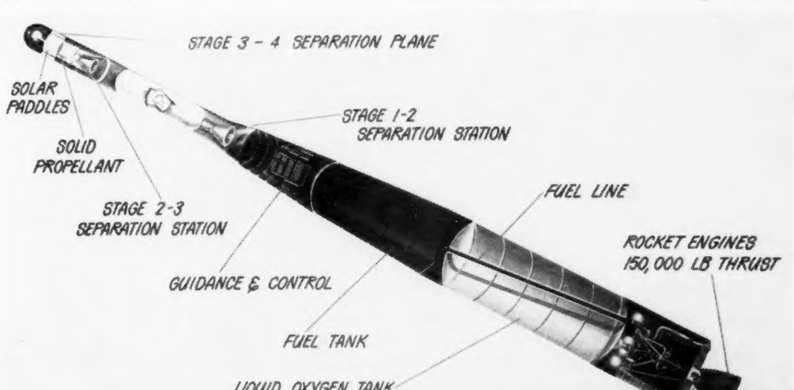
Signals returning from successive reflections are delayed more and more with respect to the time of emission of the original pulse. The total duration of this delay is proportional to the zigzag distance to each point of reflection. Since the heights of various ionospheric layers gradually change with time, there is a slowly varying background pattern against which any new source of reflection will suddenly emerge.

Project Tepee, originated by W. J. Thaler of ONR, employs frequencies that are readily scattered by the cloud of hot gases left in the wake of a major rocket launching. Moreover, satellites traveling through ionized regions of the atmosphere pick up electrons from their surroundings and then attract a fast-moving swarm of positively charged ions. The disturbance thus created can also be detected by the Tepee system.

Nuclear explosions, lightning flashes, and aurorae can cause sudden pips on the oscilloscope screen used at the receiver, but these can generally be distinguished from satellite echoes. At present, because of the instability of the ionosphere and the low transmitter power, the Tepee system is about 95-per-cent reliable.

In some other modifications of the radar principle, continuous rather than pulsed radiation is used, and the receiver is at a great distance from the transmitter. For example, as early as October, 1957, the first Sputnik was tracked by John D. Kraus at Ohio State University by means of 20-megacycle WWV transmissions reflected from the ionized trails of the orbiting satellite and its carrier rocket. Recently, at Cornell University, the 10- and 15-megacycle transmissions from WWV have been found to give two distinctive types of reflection from the ion trail of Discoverer I, whose radio was not functioning properly.

The Advanced Research Projects Agency has used other methods for detecting silent satellites, its observing stations forming a line across the southern part of the United States. Transmitters in Alabama and Arizona send out 50 kilowatts of continuous power at the Minitrack frequency, 108 megacycles. Receiving stations utilize great antenna arrays so that interference patterns set up by radiation reflected from satellites can be measured. Receivers for the eastern branch are located in Georgia and Mississippi, and for the western in New Mexico and California. The central section of ARPA's detection line, with transmitter at Ft. Sill, Oklahoma, and receivers in Arkansas and New Mexico, utilizes the Doppler principle.


STAGE 3 - 4 SEPARATION PLANE
SOLAR PADDLES
STAGE 1-2 SEPARATION STATION
SOLID PROPELLANT
FUEL LINE
STAGE 2-3 SEPARATION STATION
ROCKET ENGINES 150,000 LB THRUST
GUIDANCE & CONTROL
FUEL TANK
LIQUID OXYGEN TANK
VERNIER ENGINES 1,000 LB THRUST

The major components of the 90-foot Thor-Able III rocket that carried the paddle-wheel satellite into space on August 7th.

DISCOVERERS V AND VI

TWO similar Discoverer satellites, fifth and sixth in the series sponsored by the Advanced Research Projects Agency, were launched into near-polar orbits from Vandenberg Air Force Base, California, within a week of one another — on August 13th at 19:00 UT and on the 19th at 19:25 UT. A major purpose of these experiments was to test the system for recovering payload capsules from orbit, but in both cases the instrument packages were lost.

In most respects Discoverers V and VI resembled earlier satellites in the series (SKY AND TELESCOPE, June, 1959, page 444). However, the Thor booster stages were fueled with a denser hydrocarbon propellant, known as RJ-1, and the additional energy placed heavier payloads into higher orbits. Before ejection of their re-entry packages, each of the 19-foot-long, five-foot-diameter satellites weighed about 1,700 pounds.

According to the telemetry report from Discoverer V, its 195-pound recovery capsule separated as planned on August 14th at 21:42 UT. Similarly, the 300-pound package carried on the nose of backward-traveling Discoverer VI was pushed away from its orbiting carrier on August 20th at 22:27 UT, but in neither case was a radio signal received from the re-entry vehicle. Extremely low temperatures in each satellite may have inactivated the batteries supplying power for the capsules. Not only would this failure silence the capsule's radios but release of the parachutes could not occur.

The orbit of Discoverer V, 1959ε, is inclined 80.0 degrees to the earth's equatorial plane, according to Space Track. Initially the nodal period was 94.1 minutes, with perigee height of 135 miles and apogee of 457. Its orbital career will probably end by early October. Discoverer VI, 1959ζ, is traveling in a plane inclined at 84.0 degrees, with initial nodal period of 95.2 minutes, perigee height 131 miles and apogee 528 miles. By mid-October it will probably plunge into the dense lower atmosphere and vaporize.

MARSHALL MELIN
Research Station for Satellite Observation
P. O. Box 4, Cambridge 38, Mass.

NEWS NOTES

AMERICAN ECLIPSE PLANS

Several expeditions are being undertaken by American astronomers for the total eclipse of the sun on October 2nd. A group from the University of Minnesota is in French West Africa to test a theory of the solar corona, proposed by Paul Kellogg and Edward Ney, that the sun's outermost atmosphere consists of trapped charged particles, similar to the Van Allen radiation belt surrounding the earth.

On the Canary Islands, University of Wisconsin scientists will attempt to map the corona, and to obtain measurements farther out in the corona than ever before, in order to study its change of temperature with height.

A joint expedition from Sacramento Peak Observatory and High Altitude Observatory is trying again to investigate the flash spectrum. Last year this group was unable to carry out its program in the Danger Islands because of a thunderstorm (Sky and Telescope, December, 1958, page 68). The party is located at the southern tip of Fuerteventura in the Canary Islands.

A 17-year-old amateur from Madison, Wisconsin, Tim Wyngaard, accompanies this third expedition. Sponsored by the National Academy of Sciences' IGY Committee and nominated by the Astronomical League, he is spending about one month at the eclipse site.

1955 FIREBALL OVER FRANCE

Among the major meteoric phenomena of recent years was a fireball, brighter than the full moon, that passed over France on November 17, 1955, at 16:30 Universal time, about half an hour after sunset. Its flight was marked by luminous outbursts and a white train which persisted for a quarter of an hour in the twilight sky before being wholly dispersed by upper-air winds. Many excellent photographs of this train were obtained.

So striking was the spectacle that A. Danjon, director of Paris Observatory, who saw the meteor himself, appealed by press and radio for reports from observers. In a single week over 6,000 letters were received from five countries.

The reports have now been analyzed by J. Kovalevsky of Paris Observatory. The object crossed France centrally in a northeasterly direction, moving in a path inclined only about 13 degrees to the horizontal, and faded out at a height of 24 miles. The meteor had its radiant point in Scorpius, not far from Antares.

Dr. Kovalevsky has calculated the original orbit around the sun that was followed by this body before it collided with the earth, on the simplifying assumption that it was a parabola. The orbit lay almost exactly in the plane of the ecliptic, and the meteoroid had been closest to the sun (about 60 million miles) one month before its destruction.

The details of this study appear in the May, 1959, issue of *l'Astronomie,* monthly journal of the Astronomical Society of France.

A LUNAR ATMOSPHERE AND PROTON BOMBARDMENT

Although refined modern observations have not given any certain indication of an atmosphere surrounding the moon, there may be a highly tenuous envelope consisting of gases released during volcanic processes (August issue, page 561) and by radioactive decay in lunar rocks (May, 1958, page 342).

Hitherto, it was thought that two opposing processes determined the properties of such an envelope: accumulation of gases from the surface, and escape of faster-moving molecules from the weak gravitational attraction of the moon. Now, at the Goddard Space Flight Center, J. R. Herring and A. L. Licht point out another important process. They find that high-speed protons known to be ejected from the sun could be very effective in stripping the moon of a gaseous envelope.

In 1951, the German astronomer L. Biermann calculated the flux of particles from the sun. This "solar wind" can be visualized as a cloud of protons, about 1,000 of them per cubic centimeter, traveling at 1,000 kilometers per second. In an elastic collision with an atom, each such proton transfers an average of 1,000 electron volts of kinetic energy, giving the bombarded particle a high enough velocity to escape from the moon.

The density of any lunar atmosphere would be reduced by a factor of 10^{11} for argon, 10^{4} for water vapor, 10^{15} for carbon dioxide, and 10^{22} for sulfur dioxide. The Washington, D. C., scientists note that their calculations are consistent with an estimate of 5×10^{-13} atmosphere for the upper limit of gas density at the moon's surface, recently obtained from radio observations of an occultation of the Crab nebula (Sky and Telescope, November, 1957, page 12). Their calculations are reported in *Science* for July 31, 1959.

UPPER-AIR FLARE

A brilliant cloud of sodium vapor was released high above the eastern United States at 4:18 a.m. Eastern standard time on August 17th, in an experiment to study high-level winds and atmospheric diffusion. Under auspices of the National Aeronautics and Space Administration, a Nike-Asp two-stage rocket was sent aloft from Wallops Island, Virginia. The nose cone contained sodium pellets and thermite in a mechanism that produced a trail of sodium exhaust after the rocket reached a height of 50 miles.

IN THE CURRENT JOURNALS

SOME RECENT RUSSIAN OBSERVATIONS OF VENUS, by Robert S. Richardson, *Griffith Observer,* September, 1959. "From his observations Kozyrev believes that there is no convection in the lower atmosphere of Venus. The atmosphere is stable at the surface where only a faint twilight prevails. All the effects of weather appear in the upper layers of the atmosphere where the sunlight penetrates. This appears to be the only point upon which all the experts are agreed – that it is dim on the surface of Venus. Our knowledge of conditions there is equally dim. And we are still groping for more information."

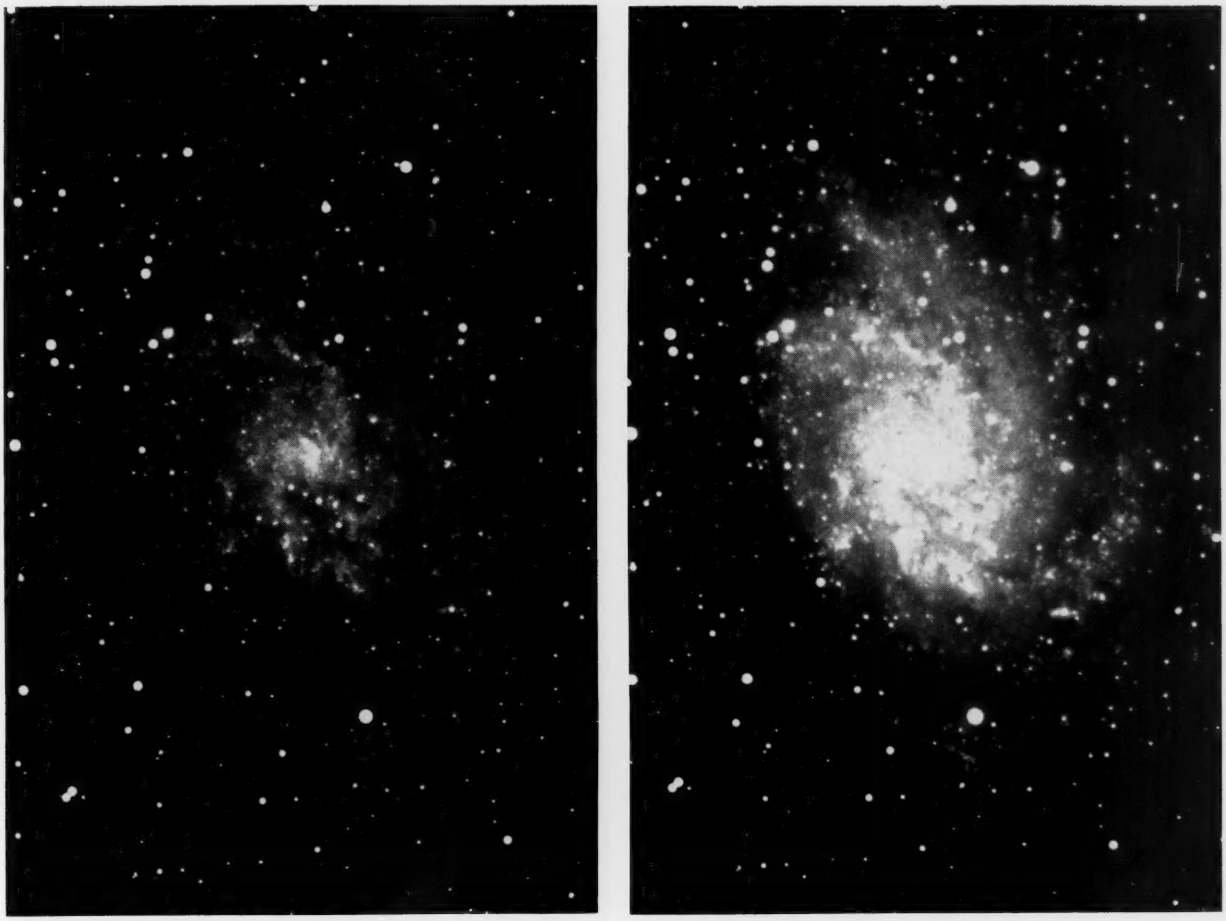
Near the top of the vehicle's climb, 150 miles above ground, the sodium trail emerged from the earth's shadow into sunlight, becoming visible as a bright orange-yellow cloud. This flare was seen by observers as far away as Alabama and Ohio. At Washington, D. C., it remained visible for half an hour. Tracking cameras at five stations were used to monitor the drift and eventual dispersion of the luminous patch.

TRANSATLANTIC RADIO VIA THE MOON

For the first time, radio messages were sent across the Atlantic Ocean by means of reflection from the moon in May and June of this year. The transmitter in England was the world's largest steerable antenna, the 250-foot paraboloid at Jodrell Bank, near Manchester. It directed Morse code and continuous-wave signals at the moon, with a power of one kilowatt at a frequency of 201 megacycles per second.

On Sagamore Hill in Hamilton, Massachusetts, the signals reflected from the moon were picked up by the 84-foot antenna operated by the Air Force Cambridge Research Center. The first message was: "Jodrell Bank to AFCRC. We'll have no trouble with fishing boats on this circuit." Tone signals were received during the June series of experiments.

At the frequency used, echoes are received only from a small central part of the lunar disk. Because of the large-scale roughness of the moon's surface, and the continual change in its orientation as the libration alters, the fraction of the central area that is effective in producing the echo is constantly varying. As a result, large increases and decreases in signal strength are observed in the course of a few seconds. Peak signals can be 100 times stronger than those in the troughs. This phenomenon of libration fading is a handicap to radio communication via the moon that can be minimized by suitable techniques.



On a single fine-grain negative of the great spiral galaxy in Triangulum, M33, the Lowell 13-inch telescope's limiting magnitude for a 45-minute exposure is 18.5, as seen in the left-hand picture. But photographic magnitude 19.7 is reached (right) when 10 negatives are superimposed. Lowell Observatory photographs.

LOWELL COMPOSITE PHOTOGRAPHS EXTEND LIMITING MAGNITUDE

By a combination of techniques, stars five times fainter than those previously observed with Lowell Observatory's 13-inch telescope have been successfully photographed with that instrument. H. L. Johnson, R. Neville, and B. Iriarte describe their methods in Lowell Observatory *Bulletin* No. 93.

Normally, a limiting magnitude of 18.0 in blue light is reached on a 103a-O plate exposed for 45 minutes with the 13-inch. Longer exposures give such an increase in sky background that recorded details become lost in the plate fog. But by using a special metol-sulfite fine-grain developer introduced by W. W. Morgan for spectrographic work, the Lowell astronomers gained half a magnitude, to 18.5.

For a further extension to fainter stars, they borrowed a technique first used in 1920 by O. H. Truman and E. C. Slipher for planetary studies. A composite picture, made by superimposing several photographs, will show features not definitely identifiable on any of the individual negatives.

For stellar photography, 10 separate plates of the same sky area were used, each exposed 45 minutes and developed in metol-sulfite. A two-times enlarged positive print was made to serve as a guide in aligning the superimposed plates. Then, with Slipher's planetary apparatus, two composite positives were made, each from five of the 10 plates, and finally combined to give a single negative. In the case of the galaxy in Triangulum, M33, pictured here, the composite has a limiting magnitude of 19.7, a gain of 1.2 magnitudes over any one individual plate and of 1.7 magnitudes over the initial limit with the 13-inch telescope.

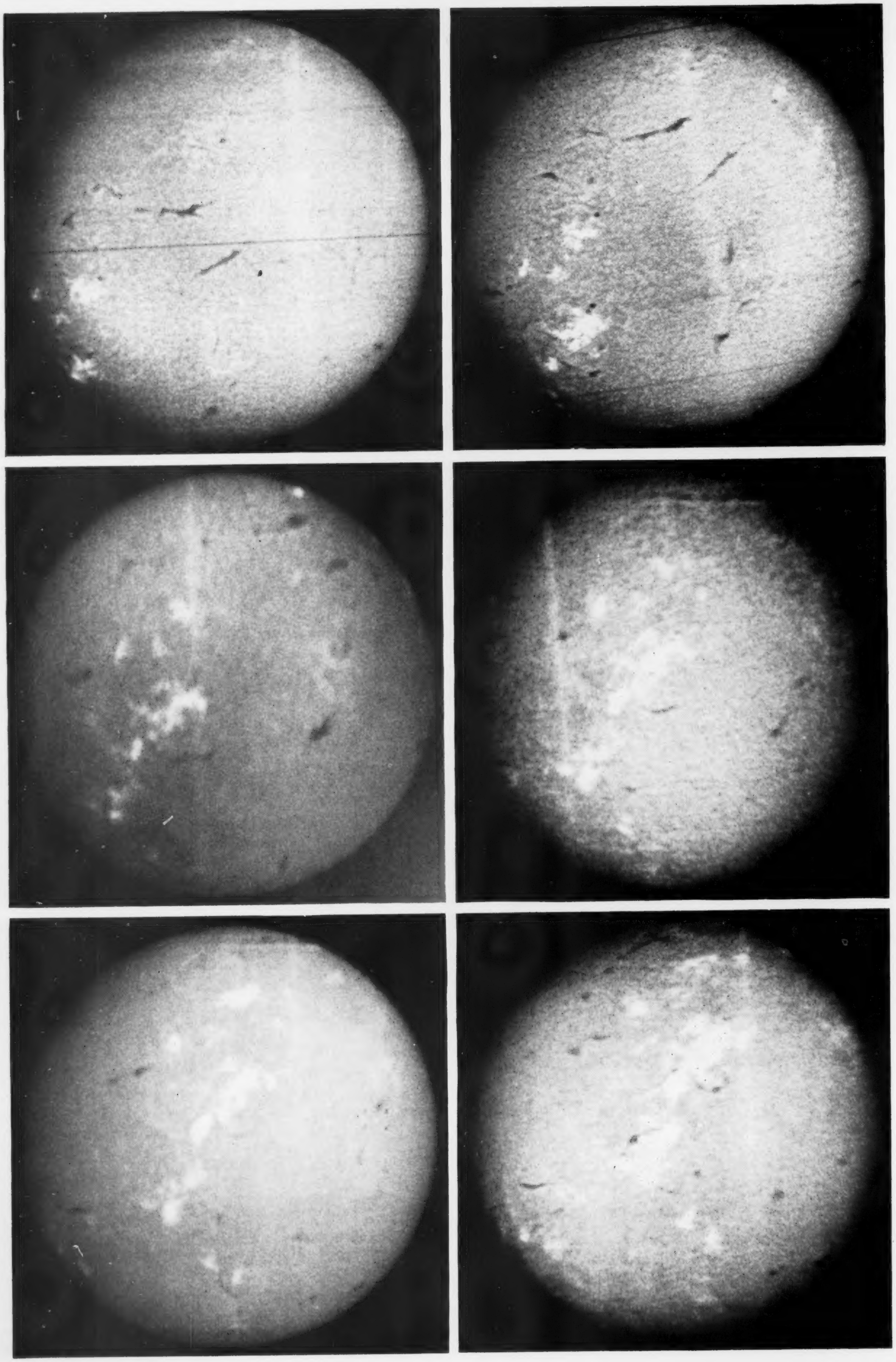
ASTRONOMY MAGAZINE CHANGES HANDS

Fifty years ago Leon Barritt published a monthly chart of the evening sky that was syndicated in many newspapers. Popular response led him and Garrett P. Serviss to expand this feature into a periodical called *Monthly Evening Sky Map*. It featured current news of the planets, a chart of their changing positions during each month, and a map of the sky for pre-dawn observers.

The magazine is now a quarterly, and has recently been published by a New Jersey amateur, Irving L. Meyer. In July it was acquired by three members of the St. Louis Astronomical Society, Donald D. Zahner, who will act as editor, Theodore P. Desloge, and Hollis E. Suits. The inventor of the Spitz planetarium, Armand Spitz, is associate editor, his interest in *Monthly Evening Sky Map* going back to 1939, when he assisted Mr. Barritt's widow to continue publication upon the death of her husband.

Mr. Zahner expects to publish bimonthly beginning in January, 1960, expanding the magazine in size and redesigning its format. He will continue to direct its contents to beginners in astronomy, both juniors and adults. Walter Scott Houston will conduct a special column, and Thomas R. Cave, Jr., will write a beginner's telescope making department. The October issue, for 1959's last quarter, has now been published.

The bimonthly will have a subscription price of $3.00 per year. Information about rates for club members and a sample copy of the October issue (25 cents) may be obtained from Sky Map Publications, Inc., P. O. Box 213, St. Louis 5, Mo.



An Amateur's Solar Observations

WALTER J. SEMERAU

NINE consecutive days of solar observing are rarely possible near Buffalo, New York, where we think ourselves fortunate to have sunshine on two or three days in a row. Yet, on every day of a vacation that I had planned to devote to solar observing, beginning July 25th, I was able to obtain spectroheliograms.

In the back yard of my Kenmore home is a small observatory, containing a spectroheliograph and the prominence telescope described on page 368 of SKY AND TELESCOPE for May, 1958. In last month's issue (page 643) details were presented of the equatorial mounting that carries both of these instruments.

Designed for photographing the sun's disk in red hydrogen-alpha light, at a wave length of 6563 angstroms, the spectroheliograph has a 2-inch objective with a focal length of 36 inches. Its optical system includes a plane diffraction grating and an 8-inch spherical mirror.

Although a period of marked solar activity occurred in the middle of July, accompanied by tremendous disturbances in radio communications and the earth's magnetic field, I was unable to work on the sun at all, visually or photographically, until the 25th. Even then, the sky cleared only for 12 minutes during the afternoon, when I exposed five frames with the spectroheliograph.

On the facing page, spectroheliograms from six different days are reproduced. In each case north is at the upper left, with east on the lower left, the sun's equator extending diagonally across the picture. Hence, the direction of solar rotation, and the general movement of spots, prominences, and other features, is toward the upper right.

The top left photograph was taken on July 26th, when the sky was a clear blue and seeing conditions were fair. Two plages or bright regions have appeared near the eastern edge of the disk, each trailing slightly behind a large sunspot group. The spectroheliogram shows only the leader spot in each case, since the high-level plages cover up the spots beneath them. Close to the central meridian are two dark filaments, one north and the other south of the solar equator. In the adjacent picture, obtained two days later, these features have moved noticeably westward.

FACING PICTURES: Photographs of the sun's disk in hydrogen-alpha light, taken by the author during his vacation late in July this year. The dates and Universal times of the exposures were: top row (left to right): July 26, 13:59; July 28, 16:43; middle: July 30, 13:16; July 31, 18:25; bottom: August 1, 13:26; August 2, 12:12. The two bright areas that appear in the eastern (lower-left) quadrant of the first picture were designated plage regions 91 and 94 by the High Altitude Observatory in Colorado. Region 94, the lower one, was the site of a flare of importance 2 on July 29th, at 19:28 Universal time, the first major activity to develop there during this nine-day period of observation.

On July 30th, although the seeing was bad, a small bright flare, estimated as of importance 1, was recorded near the northwestern limb, as shown at the top of the middle left-hand picture. On this day clouds stopped my observations after half an hour.

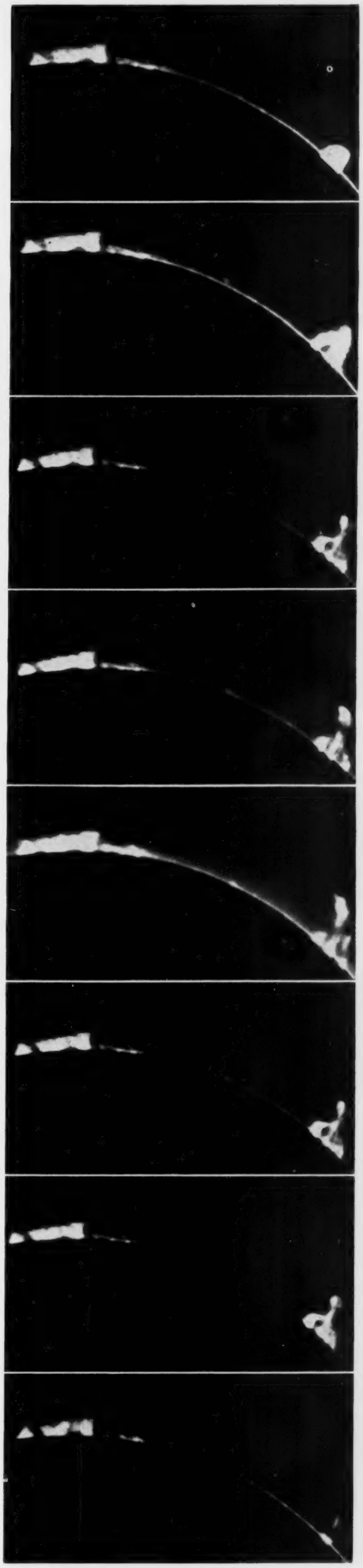
Activity on the 31st was similar to the previous day's, but no flares were seen or photographed. The two dark filaments, so conspicuous throughout this period, were passing over the west limb as quiescent prominences, somewhat changed in size.

There was much activity on August 1st. In the plage area that was now in the northwest quadrant (near the top of the disk), a class-2 flare can be seen, and another, of class 1, is in the second plage area just above center. In the latter plage a dark filament appeared and disappeared, its shape and distinctness changing as the wave length used for the observation was slightly altered.

The final picture, in the lower right, was obtained the next day, when the seeing was better than average and all the dark features showed up well. The same filament then appeared clear and sharp, above and right of center.

During these same days I obtained records of solar prominences. Reproduced at the right are selected frames from a series of 30 exposures, taken at minute intervals on July 26, 1959, from 15:30 to 16:00 Universal time. They trace the development and decline of a small eruptive arch prominence on the east limb of the sun, about 10 degrees north of the solar equator. A quiescent prominence is in the left-half portion of the field. From top to bottom, the pictures were taken at these Universal times: 15:00, 15:03, 15:08, 15:14, 15:18, 15:20, 15:24, and 15:30.

When, at 19:25 UT on August 2nd, the sun was finally blocked from view by local obstructions, one of the most interesting and educational vacations in my experience had ended.



Amateur Astronomers

TUCSON AMATEURS VISIT KITT PEAK OBSERVATORY

ON JULY 26th, under the guidance of Dr. A. Keith Pierce, associate director of Kitt Peak Observatory, members of the Tucson Amateur Astronomers took a field trip to view construction progress at the nation's new optical observatory in southern Arizona.

The visitors found much activity on the mountaintop, where it was 25 degrees cooler than Tucson's 97° Fahrenheit that day. The area is changing rapidly from its original primitiveness pictured in SKY AND TELESCOPE for August, 1958, page 493. Shops, caretaker's house, office and laboratory, dormitory, water-collection system, and sewage disposal all are under development.

The building of the 36-inch telescope was nearing completion, and the telescope itself is expected about October. When standing in the 36-inch dome, we were just as high as the 6,875-foot summit of Kitt Peak itself, which could be seen to the north. The 16-inch telescope is as yet the only instrument in operation.

But work has already begun on foundations for the 80-inch reflector, which will be the world's fifth largest optical telescope. Large broken rocks, just blasted, are the predominant feature of the landscape at this spot.

The 60-foot tower formerly used in the site survey has been moved close to the location of the four-million-dollar solar telescope (SKY AND TELESCOPE, February, 1959, page 183). The tower is now being used for air turbulence tests and microthermal studies. At the solar site, drilling is under way to obtain cores of the ground's substructure for locating the 300-foot long, 20-by-20-foot diagonal tunnel that will be the underground part of the solar telescope.

A water-pressure tank, 10 by 52 feet, is set up not far from the site of the University of Arizona's 36-inch reflector, which will be moved to Kitt Peak from Tucson. We marveled that such a large tank could have been brought up in one piece over the six miles of steep, winding road that leads up the mountain.

DONALD J. STRITTMATTER
1840 E. Lee St.
Tucson, Ariz.

NORTHWEST CONVENTION

The first woman chairman of the Northwest Region of the Astronomical League is Mrs. Fred Cummings, Tacoma, Washington, who was chosen during the closing session of the regional convention at Tacoma in July. Other officers are Walter M. Grizzle, Wenatchee, Washington, vice-chairman; Mrs. W. Henry Kobs, Portland, Oregon, recording secretary; Norman C. Dalke, Seattle, executive secretary; Howard J. Richards, Portland, treasurer; and the undersigned, regional representative.

Our total of 112 registrations broke the previous attendance record for the region set at Portland in 1958. The College of Puget Sound was the scene for most activities, including a sky party, which was preceded by a lecture on double stars by Dr. R. M. Petrie of the Dominion Astrophysical Observatory.

EDWARD J. NEWMAN
324 W. Yakima Ave.
Yakima, Wash.

MONTREAL, CANADA

The Montreal Centre of the Royal Astronomical Society of Canada has an active group of lunar observers, under the leadership of George Wedge. An interesting training project was begun two years ago. Each new observer is supplied with blank forms representing the lunar disk, on which he draws each crater as he identifies it. Of the 15 persons who have taken part in the training program, two have identified over 220 craters. For the more advanced members, there is a co-operative study of the details in six important craters, including Alphonsus.

THIS MONTH'S MEETINGS

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Dallas Health and Science Museum Planetarium. October 26, Richard T. Harvey, "Astronomical Measurements."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. October 7, Dr. Robert Fleischer, Rensselaer Polytechnic Institute, "Listening in on the Universe."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. October 3, Calvin S. McCamy, National Bureau of Standards, "Color Perception from Abridged Color Projection Systems."

STELLAFANE IN 1959

MEMBERS of the Astronomy Section of the Rochester Academy of Sciences in New York State prepared the program for the August 8th convention of telescope makers at Springfield, Vermont. Some 260 persons came to renew old acquaintances and to see the instruments on display.

In the afternoon four informative talks were given: "Telescope Construction in a Large Astronomy Club," by Richard Luce, New York Amateur Astronomers Association; "Diffraction Effects in Reflecting Telescopes," by Edgar Everhart, University of Connecticut; "A Field Flattener for Average Amateur Paraboloids," by Charles Spoelhof of the Rochester group; and "The All-Purpose Telescope," by Dr. Henry E. Paul, Norwich, New York.

An annual feature of this meeting is the judging of telescopes for excellence of design, workmanship, and ingenuity. First prize for mechanical excellence went to Joseph Glatz of Yonkers, New York, for his 6-inch f/8 Newtonian. The polar axis of this instrument's mounting is equipped with a gravity drive that uses an alarm clock for a governor.

Edward C. Dougherty of Watervliet, New York, received second prize in the same division for his Springfield mounting for a large telescope. The equipment weighs half a ton and was four years in

Members of the Tucson Amateur Astronomers visit the site (left) of the 80-inch reflector of Kitt Peak Observatory. The building for this instrument is scheduled for completion early next year. At the right, the future location of the great solar tower telescope is marked by a drilling rig. Photographs by Donald J. Strittmatter.

construction. Both axes are electrically driven, with the rate fixed or variable by means of electronic frequency controls.

Third prize was awarded to Orvar Braaten, Elmsford, New York, for his 8-inch Newtonian and its split-ring horseshoe mounting made from a large disk of multiple sheets of plywood, both axes being motor driven.

Because of unfavorable weather, the usual evening star party was omitted. Next year's convention is on July 30th.

ESCONDIDO, CALIFORNIA

Several months ago, in a few articles I wrote for the local newspaper on astronomy, I mentioned that although the largest telescope in the world – the 200-inch Hale reflector at Palomar Observatory – was located nearby, there was no amateur astronomical society here. An invitation was then extended to interested persons to contact me for the purpose of setting up a club.

On July 25th we had our first meeting at my home, with 16 persons present, and adopted the name Palomar Amateur Astronomers. Then we observed Jupiter, Saturn, and M16 through my 12½-inch telescope.

Other amateurs in our area who may wish to attend our bimonthly meetings are asked to write for further information.

MARTIN A. SLOAN
2418 Alexander Dr.
Escondido, Calif.

LATIN-AMERICAN BULLETIN

In March, the first number of the *Bulletin* of the Latin-American Astronomical League was published by its president, Victor Estremadoyro, in Lima, Peru. It contains a list of the current league membership, consisting of four societies in Argentina and as many in Peru, five in Chile, and one each in Colombia, Ecuador, and Nicaragua. (See SKY AND TELESCOPE, February, 1959, page 205.)

NEW JUNIOR GROUPS IN FLORIDA AND MINNESOTA

There are 38 members in the Astro-Gators Junior Astronomy Club. The director is Leo Durrance, 1061 Riverside Ave., Jacksonville, Fla.

Thirty juniors have formed the Astronomers Club of St. Paul. Interested persons should contact Michael Charland, 896 E. Jenks Ave., St. Paul 6, Minn.

MEMPHIS, TENNESSEE

Last spring, the Memphis Astronomical Society presented a series of seven lectures on the space age to the public. The weekly talks, given at the adult education center, consisted of a survey of the universe and a discussion of the methods and rewards of space travel. Utilized for one topic, "Visiting the Heavens," was the Memphis Museum Planetarium, as well as several telescopes.

HERE AND THERE WITH AMATEURS

Most of these societies hold regular meetings once or twice monthly, at which interested persons are always welcome. Details of each society's program can be obtained from the official whose name and address are given here.

*Members receive *Sky and Telescope* as a privilege of membership.
†Member organization of the Astronomical League.
‡Member organization of the Western Amateur Astronomers.
°Society has junior section.
‖Independent junior society.

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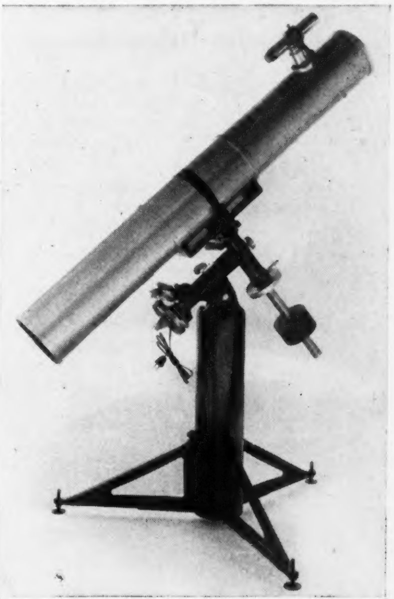

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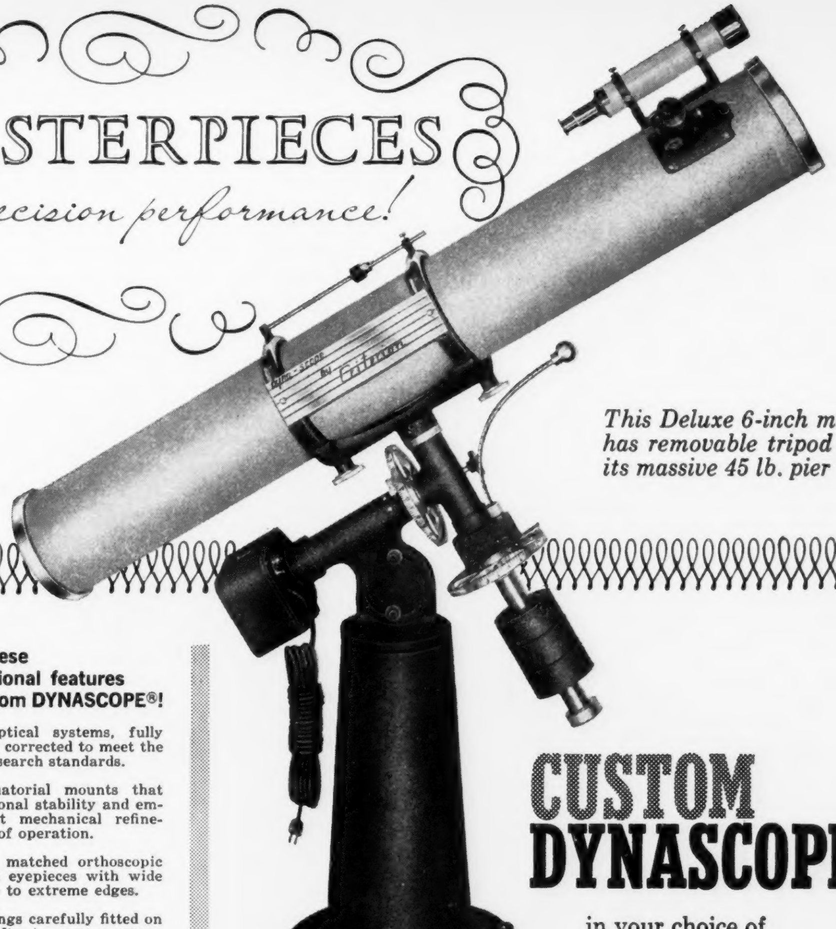

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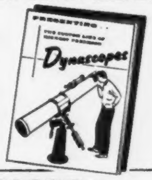

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OBSERVER'S PAGE

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FOUR BRIGHT COMETS OF 1959

EVER since its rediscovery on May 8th as a 19th-magnitude object, periodic Comet Giacobini-Zinner has been steadily brightening (see page 614 of the September issue). On August 30th, Elizabeth Roemer noted it was visible for the first time in the 5-inch finder of the Naval Observatory's 40-inch reflector at Flagstaff, Arizona.

The following provisional ephemeris shows the path of Giacobini-Zinner from Ophiuchus across Sagittarius in the evening sky, according to C. Dinwoodie in the 1959 *Handbook* of the British Astronomical Association. For each 10th day at 0^{h} Universal time are given the comet's right ascension and declination (1950 coordinates) and the predicted magnitude: Sept. 29, 17^{h} 11^{m}.9, +14° 19′, 10.5; Oct. 9, 17^{h} 38^{m}.7, +6° 56′, 9.8; 19, 18^{h} 14^{m}.5, −3° 48′, 9.2; 29, 19^{h} 04^{m}.5, −19° 06′, 9.0; Nov. 8, 20^{h} 19^{m}.1, −37° 00′, 8.8.

Although the predicted magnitudes are highly uncertain, Giacobini-Zinner should be visible with amateur telescopes low in the southwest after sunset. Perihelion is on October 25th.

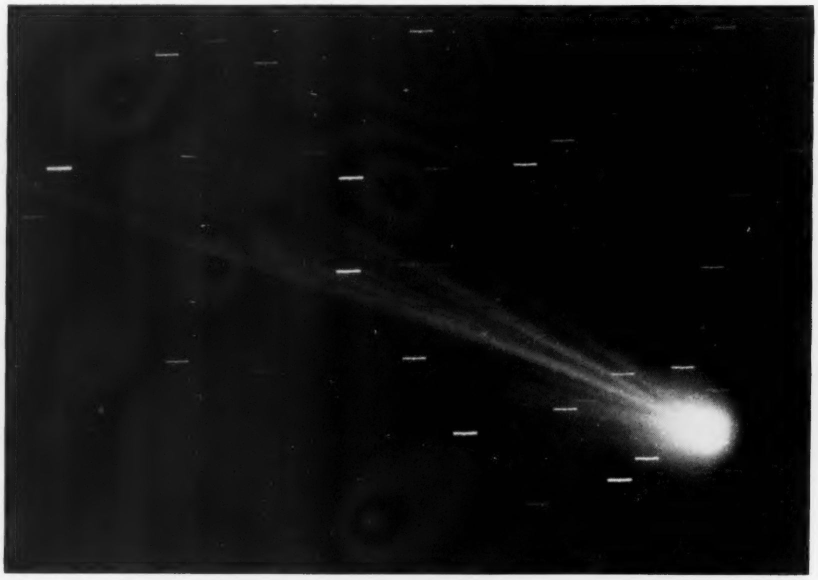
Three new comets were discovered during the second half of August. While comparing sky photographs taken on July 26th and 31st, M. J. Bester and C. Hoffmeister, at Boyden Observatory in South Africa, detected an 8th-magnitude comet in Sagittarius. Known as 1959d, the Bester-Hoffmeister object faded as it moved southeastward into the constellation Microscopium. Orbit computations by J. Schubart, Sonneberg Observatory, East Germany, show that its closest approach to the sun had occurred on July 15th, at 116 million miles.

Both of the two other finds were made in a single week by G. E. D. Alcock, of Peterborough, England. On August 25th, he detected 1959e in Corona Borealis. It traveled rapidly southeastward across the evening sky, by the end of September being just east of Scutum. A narrow tail, five minutes long, was photographed on August 29th by Dr. Roemer with the 40-inch reflector. She points out that this comet is much bluer than Giacobini-Zinner, as indicated by a comparison of exposures with red- and blue-sensitive emulsions.

L. Kresak in Czechoslovakia has calculated a preliminary orbit for 1959e, finding that it was nearest the sun on August 18th. The last two predicted positions from his finding ephemeris in *Circular* 1688 of the International Astronomical Union are: Sept. 19, 17^{h} 59^{m}.3, +4° 49′; 24, 18^{h} 24^{m}.9, −1° 57′.

According to David Meisel, Association of Lunar and Planetary Observers, the visual magnitude of Comet 1959e was 11 on August 31st and September 4th. A fine series of photographs was obtained by Mark Zillman, Danville, Illinois, with a 4-inch f/5 lens.

Mr. Alcock's second discovery, 1959f, is the brightest comet of the year, so far,



The beautiful structure of Alcock's Comet 1959f is shown in this photograph taken on the morning of September 1, 1959, by Elizabeth Roemer with the 40-inch reflector of the U. S. Naval Observatory's station at Flagstaff, Arizona. This is an enlargement to a scale of 17 seconds of arc per millimeter of a 10-minute exposure on Eastman 103a-O emulsion, without a filter. Official U. S. Navy photograph.

being of magnitude 6. His first sighting of it was on the morning of August 30th, near the star Zeta Cancri. Preliminary orbit calculations by Kresak gave the date of perihelion passage as September 15th, when the comet was expected to be very bright, perhaps 1st magnitude, but only 10 degrees south of the sun. Later the fading comet was to pass into the evening sky, the last two predicted positions being: Sept. 24, $12^h\,41^m.1$, $+4^\circ\,52'$; 29, $13^h\,01^m.2$, $+10^\circ\,14'$.

Comet Alcock 1959f was observed visually and photographically on September 4th by Alan McClure, at Mt. Pinos, California. In 12 x 70 binoculars the comet appeared about magnitude 5.2, with a tail $1\frac{1}{2}$ or two degrees long. But his 13-minute exposure with a $5\frac{1}{2}$-inch f/5 lens on a blue-sensitive emulsion showed a tail length of three degrees, 50 minutes.

On the following morning, at Fairmont, West Virginia, Mr. Meisel recorded its visual magnitude as 5.5. Even though the comet was only five degrees above the horizon, in twilight, he could see about 25 minutes of the tail in his 6-inch reflector with a 40x eyepiece.

Four of 1959's six comets were discovered in Arizona. Comet Slaughter-Burnham, 1959a, was found at Lowell Observatory, and periodic Comet Arend, 1959c, was recovered by Dr. Roemer at Flagstaff on July 6th.

A NAKED-EYE METHOD FOR FINDING VENUS BY DAY

ONCE AGAIN, the season is favorable for observing Venus in the daytime without optical aid. The only requirements are that the sky be clear, deep blue, and the planet at least 20 degrees high.

Of course, for the next few months, Venus will be rising ahead of the sun, so one could locate the planet near dawn and follow it as the sky brightens. But for those who would like to locate Venus in the middle of the day without maintaining a protracted watch, the accompanying ephemeris will be useful. It is similar to the schedule on page 353 of the August, 1954, issue.

Briefly, the method is to observe on the preceding night a reference star whose declination is approximately that of Venus. Therefore, the daily circles of the star and Venus around the sky are almost the same, and the planet follows the star by a known time interval. At night, align the star with a chimney, flagpole, corner of a building, or the like, and make a reference mark on the ground. Return to this point after the time interval given in the table, and Venus can be seen with the naked eye if sky conditions are right.

All nine stars listed may be found on the proper monthly star charts published in SKY AND TELESCOPE. However, Tau Ceti is not labeled on any of these. It is the star to the left, east in the sky, and slightly north of Beta.

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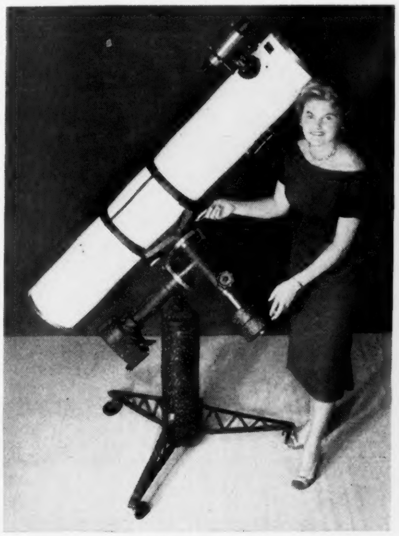
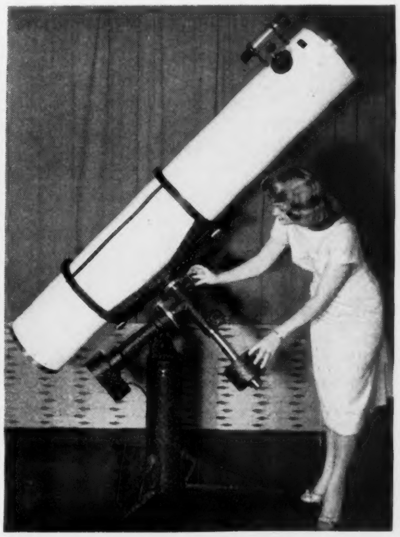
Thus, more than six years ago we pioneered the larger, but sensibly priced Newtonian reflecting telescope field. Success brings competition and imitation from others. Therefore, it is well to remember that ASTROLA was first and is still far ahead in quality and performance. In recent months we have greatly expanded our facilities for producing not only more ASTROLA Reflectors but much larger instruments. We are now doing all our own instrument machine work, so that we may give much more rapid delivery on each and every ASTROLA, but we also have even closer quality control.

Here are a few reasons why ASTROLA sales remain ahead of production:

1. ASTROLAS are by no means mass-produced, each instrument being carefully hand-assembled and each telescope completely field-tested before leaving our shops.
2. Each complete ASTROLA has been painstakingly engineered and meets every requirement of discriminating telescopists.
3. Every complete ASTROLA and every telescope mirror that we make or refigure are guaranteed unconditionally to give identical inside- and outside-of-focus star images, your assurance of ultimate optical quality.



All-New De Luxe Model "B" 8-inch ASTROLA, f/7, with rotating tube, clock drive, setting circles, and 3 oculars (85x, 210x, 360x, or 3 of your choice).
$590.00
plus $12.50 packing and crating charges.



The Completely New De Luxe Model "C" 10-inch ASTROLA, f/7, complete with rotating tube, clock drive, setting circles, and 4 oculars (74x, 111x, 222x, 444x, or 4 of your choice).
$750.00
plus $15.00 packing and crating charges.

	STANDARD	DE LUXE
STUDENT ASTROLA, 6-inch, f/7 or f/9	**$200.00**	—
ASTROLA MODEL "B", 8-inch, f/6, f/7, or f/8	**$390.00**	**$590.00**
ASTROLA MODEL "C", 10-inch, f/6, f/7, or f/8	**$495.00**	**$750.00**

NEW PYREX TELESCOPE MIRRORS AND REFIGURING

If your present telescope is not giving truly outstanding performance, let us refigure your mirror to our standard quality, and furnish you an elliptical diagonal plus aluminizing, return postage prepaid.

	NEW PYREX MIRRORS f/5 through f/10	REFIGURING f/5 through f/10
6-inch	**$ 60.00**	**$ 35.00**
8-inch	**$ 92.50**	**$ 50.00**
10-inch	**$160.00**	**$ 75.00**
12½-inch	**$250.00**	**$120.00**

Immediate delivery on new 6-, 8-, and 10-inch mirrors of normal focal ratio. Send for our newest 1960 full-color catalogue.

When in the Los Angeles-Long Beach area, visit our display room. Always in stock are many small reflectors and refractors, plus a large assortment of astronomical literature. Generous allowances on trade-ins.

CAVE OPTICAL COMPANY
4137 E. Anaheim St., Long Beach 4, Calif.
Phone: GEneva 4-2613

When you build your telescope build a good one.

CLEVELAND PARTS

are designed to match
and machined to fit

YOU'LL put a lot of time and work into your telescope before it's finished. If you want a fine, professional-looking instrument at low cost, and smooth, trouble-free performance, use guaranteed Cleveland parts. They're first choice of ATM's because they go together easily without special tools. You'll be proud of your Cleveland.

CLEVELAND EQUATORIAL MOUNT

1 Rotating base permits you to set up anywhere, then easily align and lock the polar axis on north. Makes accurate locating and tracking much easier.

2 Quick-adjusting, positive-locking tube clamp with concealed stop permits rotation of tube in saddle, keeps tube in correct balance, prevents sliding.

3 Husky, vise-grip latitude adjustment is easy to change, stays where you put it. We set it to your latitude before shipping.

4 Rigid, high-strength aluminum construction eliminates excessive weight, prevents rust.

5 All parts accurately machined to close tolerances for smooth, trouble-free operation. Designed for easy addition of accessories.

6 Accurately ground and polished steel axles, extra-long bearings and large brakes provide free movement and precise control.

7 Sturdy, cast-aluminum, tapered channel legs open to fixed position, require no folding braces. Close easily for carrying.

SPECIFICATIONS: Heavy-duty saddle, tube clamp, axle bearings, rotating base, tripod top, tapered channel legs, and extra pier top are cast aluminum. Axles are 1¼" ground and polished steel. Bearings are 5½" long. Large-area brakes, knurled bronze-aluminum alloy adjusting knobs. Brass thrust washers at all friction points. Knurled knobs lock rotating base in V groove in tripod top, release for easy transfer to permanent pier. Latitude is adjustable 0° to 55°. Latitude bolt, leg bolts, nuts, washers cadmium plated. Weight 23 lbs.

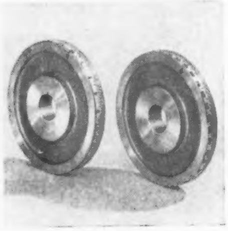
PRICE LIST

EQUATORIAL MOUNT		
Complete, for 7" tube	$ 79.50	f.o.b.
Without legs	69.50	"
Complete, for tubes to 9" x 60"	89.75	"
Without legs	79.75	"
Pier top for permanent mount	5.95	"
COUNTERWEIGHT 12½ lbs.	4.95	"
Extra weight, per pound	.50	"
ALUMINUM TUBE 7" O.D. x 60"	14.85	"
6" MIRROR CELL for 7" tube	8.35	ppd.
DIAGONAL HOLDER for 1¼" x 1¾" x ¼" elliptical or rectangular mirrors or 1¼" prism. (Specify diagonal and tube size)		
For 7" diameter tube	7.95	"
For tubes up to 10" diameter	9.15	"
1¼" EYEPIECE HOLDER	7.95	"
SETTING CIRCLES 1" to 2" bore. (Specify shaft diameter) Per pair	12.75	"
COMPLETE PARTS and instructions for building the 6" Cleveland, except optical parts	129.75	f.o.b.
6" PYREX MIRROR f/8 1/10 wave, parabolic, beryllium coated, with matching 1/10 wave, 1.25" x 1.77" diagonal	67.50	ppd.

Add 3% sales tax on Ohio orders.

COUNTERWEIGHT Lead and antimony. 3¾" diam. x 3" with 1" or 1¼" bore. Weight 12½ lbs.

TELESCOPE TUBE Extruded aluminum. 7" O.D. x 0.072" wall x 60" length. Not machined.



SETTING CIRCLES 5" cast aluminum with machined faces. ½"-wide scales are matte-white aluminum with large, legible figures and accurate black graduations. 1" to 2" bore. Specify shaft size.

6" MIRROR CELL Solid plate protects mirror. Ring housing reduces convection currents. Improved clips hold mirror without pressure. Shockproof, cushioned adjustments prevent vibration, keep mirror in collimation. No springs. Cast aluminum, machined for 7" O.D. tube.

DIAGONAL HOLDER Fully adjustable, shockproof design. One turn moves mirror position 0.050". Three screw adjustments give you perfect control of mirror angle, make collimating easy. Made for 1¼ x 1¾ elliptical or rectangular mirrors, or 1¼" prisms, tubes up to 10". Specify mirror type, size, and tube I.D. when ordering.

1¼" EYEPIECE HOLDER Acme-threaded brass sleeve in accurately machined, cast-aluminum housing gives you smooth, micrometer-sharp focusing. One turn moves eyepiece 0.125". Stays where you set it. Only one moving part.

CLEVELAND ASTRONOMICS

BOX 209, CHAGRIN FALLS, OHIO

be well located for observation at the end of evening twilight, and it is expected that Venus will be observed around midday. The kind of time used by the observer is immaterial; it may be local, standard, or daylight saving. The planet's lag has been corrected for the difference between sidereal and solar time intervals.

In the table, each star's magnitude is given; then, for the date of the star observation, the planet's lag in hours and minutes. The letter N indicates that Venus has a more northerly declination than the star; S is used when the planet will be somewhat south; and the symbol is omitted on days for which both objects have nearly the same declination.

As an example, suppose you wish to find Venus by day on October 17th. According to the ephemeris, Beta Aquilae, magnitude 3.9, is the star to use. On the 16th Venus is lagging behind this star by 14 hours 47 minutes. If on that evening the star is lined up with a terrestrial landmark at, say, 10:13 p.m., Venus will be very nearly at the same point in the sky, though slightly south, 14 hours 47 minutes later, or at 1:00 p.m. on the 17th.

Beta (β) Aquilae, 3.9: Oct. 1, 14:13, N; 2, 14:14, N; 3, 14:16, N; 4, 14:18, N; 5, 14:20, N; 6, 14:22, N; 7, 14:24, N; 8, 14:26, N; 9, 14:29, N; 10, 14:31, N; 11, 14:34, N; 12, 14:36; 13, 14:39; 14, 14:42; 15, 14:44, S; 16, 14:47, S; 17, 14:50, S; 18, 14:53, S; 19, 14:56, S; 20, 14:59, S; 21, 15:02, S; 22, 15:06, S; 23, 15:09, S; 24, 15:12, S; 25, 15:15, S; 26, 15:19, S.

Gamma (γ) Piscium, 3.8: Oct. 27, 12:01, N; 28, 12:04, N; 29, 12:08, N; 30, 12:11, N; 31, 12:15; Nov. 1, 12:18, S; 2, 12:22, S; 3, 12:25, S; 4, 12:29, S; 5, 12:33, S; 6, 12:36, S.

Alpha (α) Aquarii, 3.2: Nov. 7, 13:52, N; 8, 13:55, N; 9, 13:59, N; 10, 14:03, N; 11, 14:06, N; 12, 14:10; 13, 14:14, S; 14, 14:18, S; 15, 14:22, S; 16, 14:26, S; 17, 14:30, S; 18, 14:34, S.

Lambda (λ) Aquilae, 3.6: Nov. 19, 17:37, N; 20, 17:41, N.

Beta (β) Aquarii, 3.1: Nov. 21, 15:20, N; 22, 15:24, N; 23, 15:28, N; 24, 15:32, N; 25, 15:37, N; 26, 15:41, N; 27, 15:45, S; 28, 15:49, S; 29, 15:53, S; 30, 15:57, S; Dec. 1, 16:02, S; 2, 16:06, S.

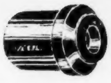
Iota (ι) Ceti, 3.7: Dec. 3, 13:22, N; 4, 13:27, N; 5, 13:31, N; 6, 13:35, S; 7, 13:40, S; 8, 13:44, S; 9, 13:48, S; 10, 13:53, S; 11, 13:57, S.

Eta (η) Ceti, 3.6: Dec. 12, 13:13, S; 13, 13:17, S; 14, 13:22, S; 15, 13:26, S.

Gamma (γ) Eridani, 3.2: Dec. 16, 10:41, N; 17, 10:46, N; 18, 10:50; 19, 10:55, S; 20, 11:00, S; 21, 11:04, S; 22, 11:09, S; 23, 11:14, S.

Tau (τ) Ceti, 3.7: Dec. 24, 13:32, N; 25, 13:37; 26, 13:41, S; 27, 13:46, S; 28, 13:51, S; 29, 13:56, S; 30, 14:01, S; 31, 14:05, S; Jan. 1, 14:10, S.

FRANKLIN MILLER, JR.
Kenyon College
Gambier, Ohio



Mounted Eyepieces

The buy of a lifetime at a great saving. Perfect war-surplus lenses set in black-anodized standard aluminum 1¼" O.D. mounts.

F.L.	TYPE	PRICE
6 mm. (¼")	Ramsden	$ 4.75
12.5 mm. (½")	Ramsden	4.50
12.5 mm. (½")	Symmetrical	6.00
16 mm. (⅝")	Erfle (wide-angle)	12.50
16 mm. (⅝")	Triplet	12.50
18 mm. (¾")	Symmetrical	6.00
22 mm. (27/32")	Kellner	6.00
27 mm. (1-1/16")	Kellner	4.50
32 mm. (1¼")	Orthoscopic	12.50
35 mm. (1⅜")	Symmetrical	8.00
55 mm. (2-3/16")	Kellner	6.00
56 mm. (2¼")	Symmetrical	6.00

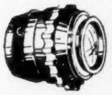
COATED LENSES 75 cents extra.

"Giant" Wide-Angle Eyepieces

ERFLE EYEPIECE (65° field) contains 3 coated achromats. 1½" E.F.L., clear aperture 2⅛". Has a focusing mount with diopter scale. Will make an excellent 35-mm. Kodachrome viewer. Magnifies seven times .... **$12.50 ppd.**

Same as above without diopter scale **$9.95**

1¼"-diam. Adapter for eyepiece above **$3.95**



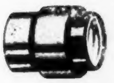
WIDE-ANGLE ERFLE (68° field) **EYEPIECE.** Brand new; coated 1¼" E.F.L. Focusing mount. 3 perfect achromats, 1-13/16" aperture **$13.50**

1¼"-diam. Adapter for eyepiece above **$3.95**

WIDE-ANGLE ERFLE 1½" E.F.L. Brand new; contains Eastman Kodak's rare-earth glasses; aperture 2"; focusing mounts; 65° field **$12.50**

1¼"-diam. Adapter for eyepiece above **$3.95**

An Economical Eyepiece



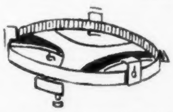
This mounted eyepiece has two magnesium-fluoride coated lenses 29 mm. in diameter. It is designed to give good eye relief. It has an effective focal length of 1¼", cell fits a 1¼" tube .... **ONLY $4.50 ppd.**

Astronomical Mirrors

These mirrors are of the highest quality, polished to ¼-wave accuracy. They are aluminized, and have a silicon-monoxide protective coating. You will be pleased with their performance.

	Diam.	F.L.	Postpaid
Plate Glass	3-3/16"	42"	$ 9.75
Pyrex	4¼"	45"	13.50
Pyrex	6"	60"	25.00

Mirror Mount



Cast aluminum. Holds all our mirrors firmly with metal clips. Completely adjustable. Assembled, ready to use.

3-3/16" Mount fits our 4½" tubing........**$4.00 ppd.**
4¼" Mount fits our 5" tubing........ **4.00 ppd.**
6" Mount fits our 7" tubing........ **6.50 ppd.**

8-POWER ELBOW TELESCOPE

8 x 50

This M-17 telescope has a brilliant-image 48° apparent field — 325 feet at 1,000 yards. The telescope can be adjusted for focusing 15 feet to infinity. It has a 2" objective, focusing eyepiece 28-mm. focal length with an Amici erecting system. Turret-mounted filters: clear, red, amber, and neutral. Lamp housing to illuminate reticle for nighttime use. Truly the biggest bargain you were ever offered. Original Gov't. cost $200.

BARGAIN PRICE ...... **$13.50 ppd.**

AIRSPACED OBJECTIVES

MOUNTED IN ALUMINUM CELLS f/15

We offer the lowest priced, hand-corrected, precision, American-made astronomical objective, mounted in a black-anodized aluminum cell. Our reputation for high-quality astronomical lenses has established us as the most reliable source in the industry.

"Those in the know" BUY FROM US BECAUSE:

Each lens is thoroughly tested by us and is guaranteed to resolve two seconds of arc or better. They are corrected for the C and F lines (secondary chromatic aberration). The zonal spherical aberration and the chromatic variation of spherical aberration are negligible. The cell is machined to close tolerances so that it will fit directly over our standard aluminum tubing, eliminating any mounting problems.

3¼" diam., 48" F.L. (uncoated) **$28.00**
Same as above with coating **$32.00**
4⅛" diam., 62" F.L. (uncoated) **$60.00**
Same as above with coating **$69.00**

We can supply ALUMINUM TUBING for the lenses above.

"BIG" ACHROMATIC TELESCOPE OBJECTIVES

We have the largest selection of diameters and focal lengths in the United States available for immediate delivery. These are perfect magnesium-fluoride coated and cemented Gov't. surplus lenses made of finest crown and flint optical glass. Not mounted. Fully corrected. Tremendous resolving power. They can readily be used with eyepieces of only ¼" focal length, thereby producing high powers. Guaranteed well suited for astronomical telescopes, spotting scopes, and other instruments. Gov't. cost up to $100.

Diameter	Focal Length	Each	Diameter	Focal Length	Each
54 mm. (2⅛")	254 mm. (10")	$12.50	83 mm. (3¼")	660 mm. (26")	$28.00
54 mm. (2⅛")	300 mm. (11.8")	12.50	83 mm. (3¼")	711 mm. (28")	28.00
54 mm. (2⅛")	330 mm. (13")	12.50	83 mm. (3¼")	762 mm. (30")	28.00
54 mm. (2⅛")	390 mm. (15.4")	9.75	83 mm. (3¼")	876 mm. (34½")	28.00
54 mm. (2⅛")	508 mm. (20")	12.50	83 mm. (3¼")	1016 mm. (40")	30.00
54 mm. (2⅛")	600 mm. (23½")	12.50	102 mm. (4")	876 mm. (34½")	60.00
54 mm. (2⅛")	762 mm. (30")	12.50	108 mm. (4¼")	914 mm. (36")	60.00
54 mm. (2⅛")	1016 mm. (40")	12.50	110 mm. (4⅜")*	1069 mm. (42-1/16")	60.00
54 mm. (2⅛")	1270 mm. (50")	12.50	110 mm. (4⅜")	1069 mm. (42-1/16")	67.00
78 mm. (3-1/16")	381 mm. (15")	21.00	128 mm. (5-1/16")*	628 mm. (24¾")	75.00
80 mm. (3⅛")	495 mm. (19½")	28.00	128 mm. (5-1/16")	628 mm. (24¾")	85.00
81 mm. (3-3/16")	622 mm. (24½")	22.50	*Not coated		

● We can supply ALUMINUM TUBING AND CELLS for the lenses above. ●

NEW! 6" LENSES

Our 6" objective does not need high-pressure salesmanship. Its sparkling performance speaks for itself. Test one, or have any qualified person test it; we are certain that you will be satisfied. If not, take advantage of our money-back guarantee.

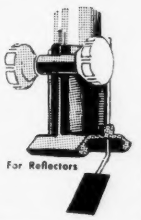
6"-DIAM. AIR-SPACED TELESCOPE OBJECTIVE

Hard-coated on 4 surfaces

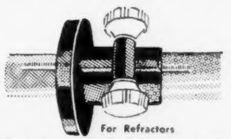
f/10 - 60" focal length	MOUNTED	$175.00
	UNMOUNTED	150.00
f/15 - 90" focal length	MOUNTED	175.00
	UNMOUNTED	150.00

We can supply ALUMINUM TUBING for the lenses above.

Rack-&-Pinion Eyepiece Mounts



For Reflectors



For Refractors

Here is a wonderful opportunity for you to own a most mechanically perfect Rack-&-Pinion Focusing Eyepiece Mount with variable tension and adjustment. Will accommodate a standard 1¼" eyepiece, positive or negative. The body casting is made of lightweight aluminum with black-crackle paint finish, focusing tube of chrome-plated brass. Focusing tube for refractors has a travel of 4", for reflectors 2", and will fit all size tubing.

REFRACTOR TYPE for 2⅛" I.D. Tubing **$12.95 ppd.**
" " for 3¼" I.D. Tubing **12.95 ppd.**
" " for 4⅜" I.D. Tubing **12.95 ppd.**
REFLECTOR TYPE (less diagonal holder) **8.50 ppd.**
DIAGONAL HOLDER .... **1.00 ppd.**

Special Coated Objective

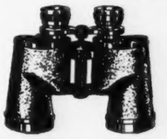
BIG 2⅛" DIAM. — 15" F.L. — $6.00

These achromatic objective lenses are tested and have the same high quality as "Big Lenses" described above, except they are seconds for slight edge chips or small scratches only. Quality guaranteed. **ONLY $6.00 ppd.**

Coated Binoculars

Beautifully styled imported binoculars. Precision made.

LOW, LOW PRICES!



American Type

"Zeiss" Type

Complete with carrying case and straps. American type offers a superior one-piece frame and clean design.

Size	Field at 1,000 yards	Type	Center Focus	Ind. Focus
6 x 15	360 ft.	Opera	—	$12.75
6 x 30	395	"Zeiss"	$18.75	16.75
7 x 35	341	"Zeiss"	20.75	17.95
7 x 35	341	American	23.50	—
7 x 35	578	Wide-Angle 11°	35.00	—
7 x 50	372	"Zeiss"	24.95	22.50
7 x 50	372	American	32.50	—
8 x 30	393	"Zeiss"	21.00	18.25
10 x 50	275	"Zeiss"	28.75	26.75
20 x 50	183	"Zeiss"	33.75	31.75

All prices above plus 10% Federal tax.

Monoculars

Brand new, coated optics, complete with pigskin case and neck straps.

	Price		Price
6 x 30	$10.00	**7 x 50**	$14.75
8 x 30	11.25	**16 x 50**	17.50
7 x 35	12.50	**20 x 50**	20.00

● "MILLIONS" of Lenses, etc. ●
Free Catalogue

We pay the POSTAGE in U. S. — C.O.D.'s you pay postage. Satisfaction guaranteed or money refunded if merchandise returned within 30 days.

A. JAEGERS

691 S Merrick Road
LYNBROOK, N. Y.

STELLAR SCIENTIFIC

STARS BY STELLAR

Even we have been amazed at the perfection attained in our Stellarscope since the development of our new, ingenious polishing machine, which not only produces all the merits of "hand work" but enables us to offer you this superior quality at surprisingly low prices.

Stellarscope is in a class by itself.

Mel L. Elzea
PRESIDENT
STELLAR SCIENTIFIC

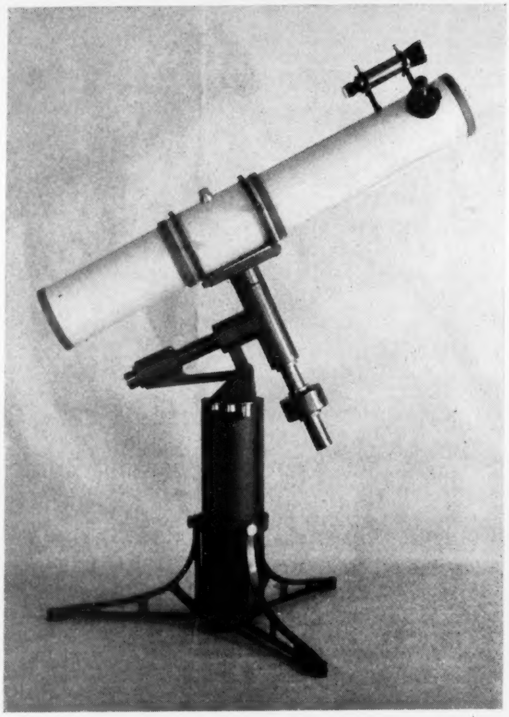
CHRISTMAS SPECIALS!

6-inch Standard, $245.00 – 6-inch De Luxe, $299.00

- ★ f/8 parabolic mirrors, quartz coated, guaranteed to perform to Dawes' limit.
- ★ 3 top-quality orthoscopic oculars, 1¼" diameter, with De Luxe models (1 only with Standard).
- ★ 7x finderscope with crosshairs, hard-coated color-corrected 50-mm. objective.
- ★ De Luxe models have exclusive, seamless, solid fiberglass tubes, mounted fully rotatable in sleeve, 50" in length.
- ★ Standard models give choice of same tube as above, or light-weight aluminum tube, 50" in length, mounted semi-rotatable on Stellar's K3 mount. (Tube sleeves available for Standard models at $22.50.)
- ★ Mirrors and diagonals fully adjustable for accurate alignment.
- ★ Stellar mount has tubular steel axes, hollow to reduce weight.
- ★ Declination axis, 1.9" diameter, 21" long, highly polished.
- ★ Polar axis, 1.9" diameter, 15" long, same high polish.
- ★ 40"-span base legs, removable for portability; turn one knob.
- ★ Cast-aluminum mount, rugged yet light, only 50 pounds.
- ★ Built-in bracket for holding 3 1¼"-diameter oculars.
- ★ Fully portable to fit average car for field trips.
- ★ Declination and polar axes completely balanced to eliminate adjustment knobs.

These Christmas Specials will be in effect only until Dec. 24, 1959.
Packing charge for either model, $10.00.

Lay-away plan available, if telescopes are desired for gifts (will deliver in December). Or you may wish to use our time-payment plan to fit your Christmas budget. Details of both plans on request.



COMPLETE OPTICS • COMPLETE TELESCOPES • COMPLETE PARTS • REFIGURING
All sizes. Write for free catalogue.

STELLAR SCIENTIFIC

P. O. BOX 1647
SANTA ANA, CALIFORNIA

This Perseid meteor was recorded by two Rhode Island amateurs with a Kodak Medalist camera, f/3.5 lens, on Perutz 21 film (ASA rating 100).

OBSERVATIONS OF THE PERSEIDS IN AUGUST

EARLY on the morning of August 13th, at Newport, Rhode Island, John T. Hopf and Robert Napier set up seven cameras to photograph the Perseid meteor shower. Last December, with five instruments they had recorded 12 Geminids in about an hour of observing time.

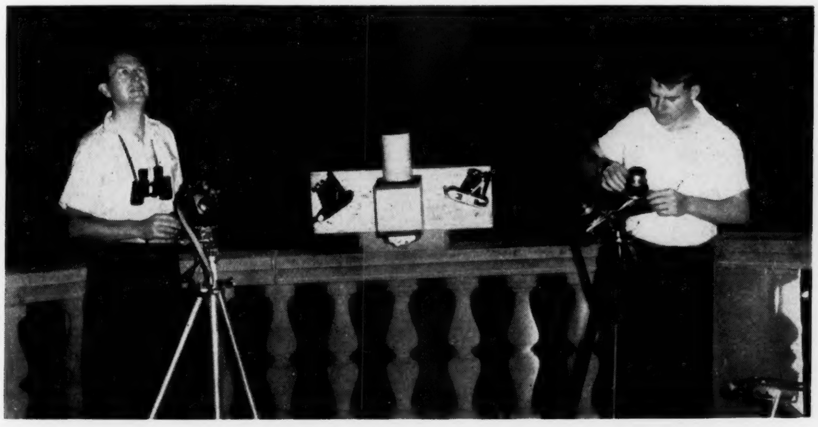
On this occasion, however, only three trails were photographed, even though as many as 39 meteors were counted in the single hour ending at 2 a.m. Eastern daylight time. The observations were partially spoiled by clouds and fog.

The bright Perseid shown here moved through Cassiopeia toward Cepheus at about 2 a.m. In the upper right the star Kappa Cassiopeiae appears as a bright streak, while Iota Cephei is in the lower left. The fading of the star trails was caused by heavy dewing of the lens toward the end of the 30-minute exposure.

Walter N. Webb, of Boston's Museum of Science, and his brother David observed at Alliance, Ohio. On August 11-12 and 12-13, their exposure time totaled four hours, 22 minutes, with two cameras and Tri-X film, capturing the tracks of eight meteors on six negatives. Together with James DeVeny they made visual meteor counts, their combined total the first night being more than 127 in $3\frac{3}{4}$ hours, while 95 meteors were seen by the Webbs in $2\frac{1}{4}$ hours the next night.

At Troutman, North Carolina, John Martin and Charles Donalson also made visual counts, observing four nights in a row. During the maximum shower activity they saw five meteors in eight minutes.

Other observations were made by Joseph A. Lupia and Richard Lemanski at Utica, New York, on the morning of August 12th. They compiled a chart on which were represented the lengths and orientations of 154 meteor trails.



John T. Hopf, left, and Robert Napier used $2\frac{1}{4}$-by-$3\frac{1}{4}$ cameras to photograph the Perseids, one of their pictures being reproduced above.

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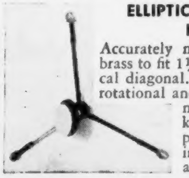

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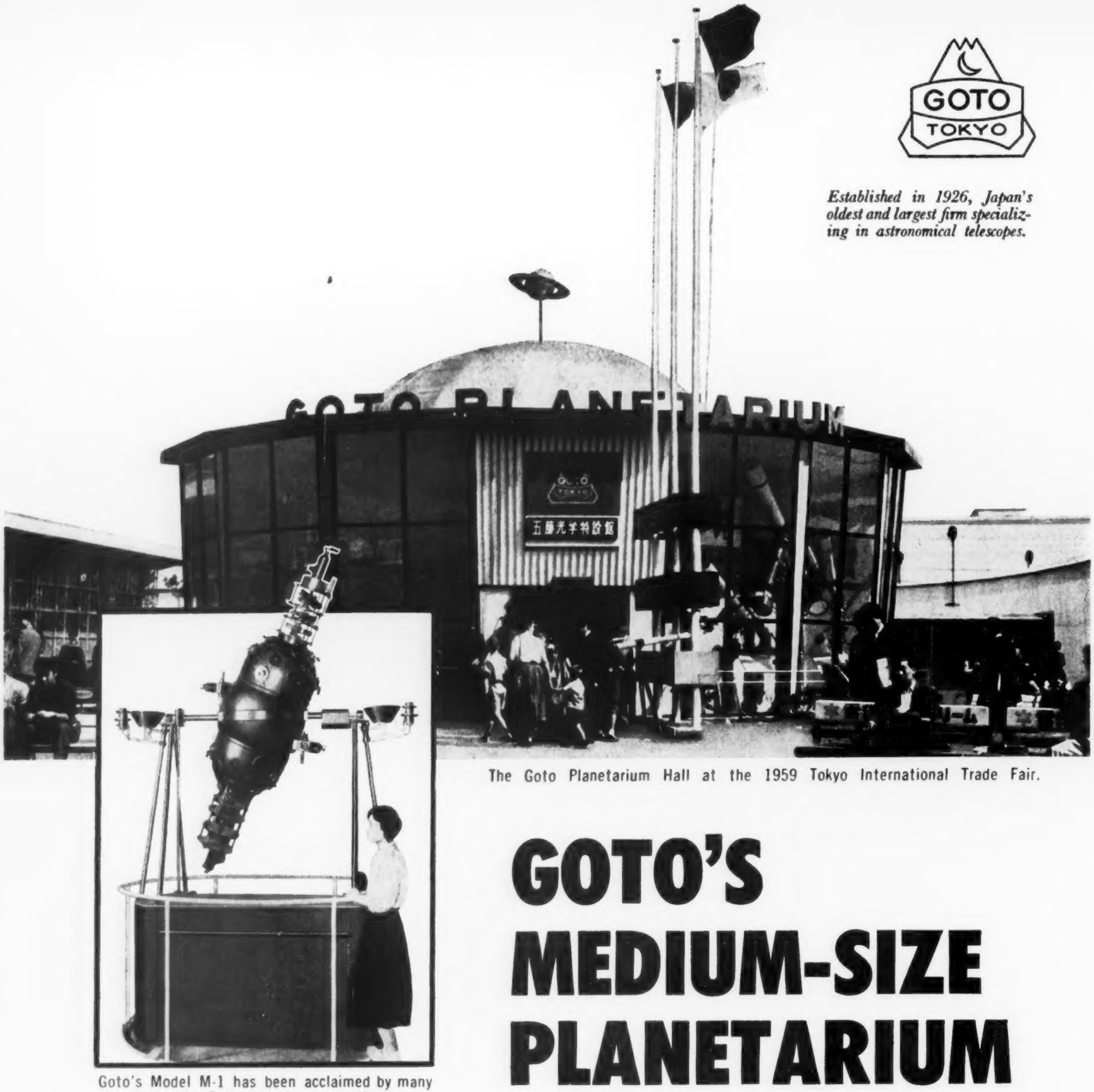

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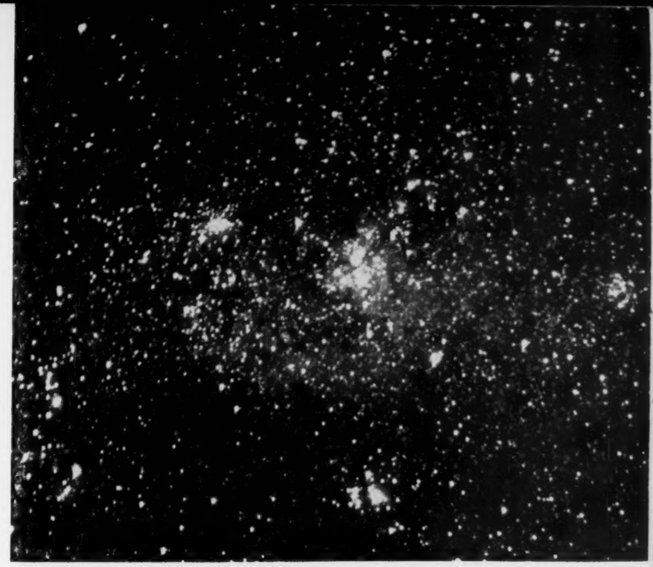
PHOTOGRAPHY OF THE MILKY WAY

CAMERAS with lenses of very short focal length can be used for photographs of the Milky Way. They enable amateurs to study firsthand the Milky Way and the Magellanic Clouds.

With my 35-mm. Contax camera, I have used three interchangeable lenses: a Biogon f/4.5 of 21-mm. focus for very wide angle, a Sonnar f/2 of 50-mm. focus for normal fields, and a Sonnar f/2 of 85-mm. focus for details of a region, such as Eta Carinae shown here.

To obtain a result similar to the visual impression of the Milky Way, I put a 4-mm. diaphragm in front of the Biogon and photographed the central region of the galaxy extending from Aquila to Norma, a distance of some 85 degrees in galactic longitude. The exposure was 100 minutes, during which the camera was driven on an equatorial mounting.

The central part of this picture is reproduced on page 671. The outer parts suffer from coma, curvature of the field, and lens absorption. But with the Biogon lens 60-degree fields can be satisfactorily covered, requiring only six such pictures to go completely around the Milky Way. I can take only three of these from my latitude here in Argentina, and would like to hear from some northern amateur who has a Biogon lens and who would want to take the other three sections of the Milky Way mosaic.



The part of the Milky Way centered on the peculiar variable star Eta Carinae. This picture was taken by Marcos A. Severin with a 35-mm. Contax camera and Sonnar lens of 85 millimeters focal length. Included in the field are several fine open star clusters, the largest being NGC 3532, left of center; NGC 3114, toward right edge; and IC 2602, bottom center.

A picture of the Centaurus-Crux region of the southern Milky Way (page 670) showing the large Coalsack dark nebula, was made with the intermediate Sonnar lens. All my films were developed by F. Kammerer, who is a member, like myself, of our local astronomical society, Amigos de Urania.

MARCOS A. SEVERIN
Sgto. Cabral 238
Rafaela, Santa Fe, Argentina

SUNSPOT NUMBERS

Below are provisional mean relative sunspot numbers for August by Dr. M. Waldmeier, director of Zurich Observatory, from observations there and at its stations in Locarno and Arosa.

August 1, 177; **2**, 210; **3**, 213; **4**, 225; **5**, 212; **6**, 207; **7**, 179; **8**, 175; **9**, 170; **10**, 155; **11**, 180; **12**, 160; **13**, 125; **14**, 139; **15**, 129; **16**, 151; **17**, 158; **18**, 174; **19**, 182; **20**, 180; **21**, 200; **22**, 200; **23**, 205; **24**, 217; **25**, 212; **26**, 220; **27**, 231; **28**, 274; **29**, 301; **30**, 292; **31**, 284. Mean for August, 198.0.

The predicted smoothed monthly sunspot number for October is 159.

The American sunspot numbers for July, derived from AAVSO Solar Division observations, will appear here next month.

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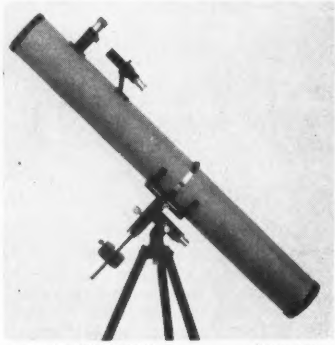

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DEEP-SKY WONDERS

FROM an amateur in Colorado, famed for its clear skies, comes this interesting query: "The books all say that the Andromeda galaxy M31 is the farthest object the naked eye can see. Shouldn't that distinction belong to M33, which is slightly farther away?"

The great galaxy in Andromeda is located at right ascension $0^h\ 40^m$, declination +41°. According to the catalogues, its main body is 2° 40′ long and 40′ wide, and of magnitude 4. This suggests it is an easy naked-eye object; indeed, it makes a good telltale for late-summer and early-fall meteor observers. If M31 cannot be seen, the sky is not clear enough for reliable meteor counts. Any beginner can see it once it has been pointed out.

M33 is the famous broadside spiral in Triangulum, at $1^h\ 31^m.1$, +30° 24′ (1950 co-ordinates). It is also large, 60′ by 40′, and of the 7th magnitude. But it would be incorrect to conclude from this that M33 is beyond the reach of the unaided eye.

There is a common misconception that the faintest stars the human eye can see are 6th magnitude. But with a pure, dark sky and good dark adaptation, the threshold of vision is actually considerably fainter. In fact, stars as faint as 8.5 have been detected by very keen-eyed persons when special precautions were taken. Many amateurs have seen the Triangulum galaxy without optical aid, despite its magnitude of 7, perhaps the remotest object thus visible. But detecting it is a task for the experienced stargazer.

If you are trying for M33 the first time, choose a perfect moonless night without any trace of haze or ground fog, and wait until Triangulum is at least 40 degrees above the horizon. First pick up M31 and study it a while, trying to see its maximum length, perhaps three degrees. Note that it is nearly on the edge of the Milky Way. On a good night when one's eyes are dark adapted, averted vision will show the Cassiopeia star clouds extending out practically to M31.

Then look at the nearby Double Cluster in Perseus, which should appear very bright and splashy. After this, search for a bright patch — the open cluster NGC 752 — just north and east of Beta Trianguli. Poor in binoculars, it looks interesting to the naked eye. M33 is at least a magnitude fainter than this.

If this test object is easy, try for M33 itself, first with averted vision, then directly. The little star just north of Alpha Trianguli should be easily seen. The Triangulum spiral may be observed as a faint, round patch, pretty uniform in brightness with no central condensation. During the season of the Perseid meteors this year, my log book lists M33 as seen on every clear night.

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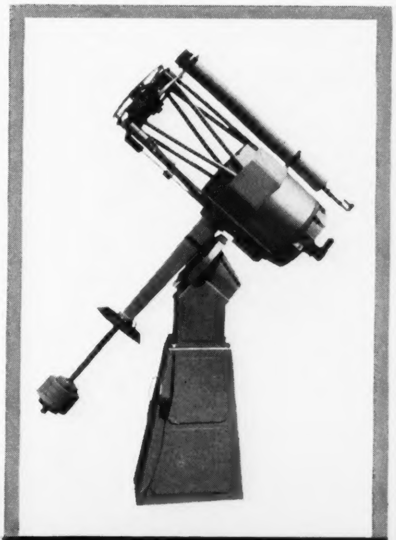

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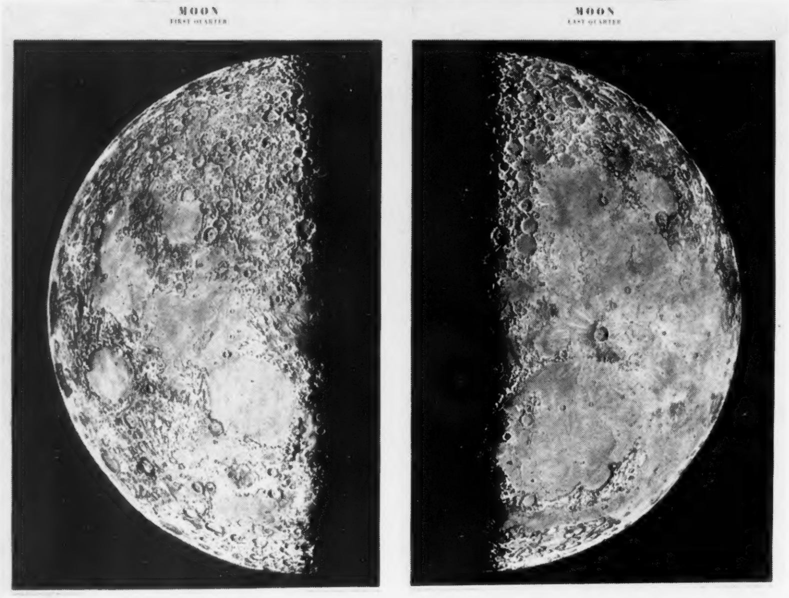

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BOOKS AND THE SKY

THE STRUCTURE AND EVOLUTION OF THE UNIVERSE

G. J. Whitrow. Hutchinson and Co., Ltd., London, 1959. 212 pages. 21s.

ORIGINALLY published in 1949 as *The Structure of the Universe,* this book has a fresh title to indicate that it is a major revision. A decade is a long time in present-day astronomy, and the author has almost entirely rewritten his first edition to keep pace with the accelerating output of new information.

Aptly subtitled "An Introduction to Cosmology," the book begins with an excellent two-chapter historical survey of the major results of astronomical observation. Detail is not overstressed; instead, one obtains a good picture of the successive revolutions of thought as our horizons have receded. The first chapter takes us up through the story of our own galaxy; the second deals with other galaxies.

Then follows a discussion of space and time: the development of geometry and the science of space in classical Greece; the appearance of time as the independent variable in dynamics as founded by Galileo; the discovery of spherical and hyperbolic geometries in the 19th century. Römer's 1676 demonstration of the finite velocity of light introduced a new concept of time, because only since then have we understood that the order of events depends on who is observing them — an astronomer here or one on Pluto or one in M31.

Relativity is the topic of the fourth chapter. Einstein's special theory deals with all systems in uniform relative motion; the general theory concerns systems moving in any way, and is the best theory of gravitation we have. The author carefully discusses the axioms of the two theories, their relation to each other and to Newton's mechanics, and their observational consequences. Although several local tests of the validity of the general theory of relativity have been devised, the main impact of that theory is on cosmology; its consideration is therefore essential in a book about the universe.

The following chapters reveal the fascinating variety of world models that cosmologists have concocted to account for the observed structure and kinematics of the universe of galaxies. The earliest models within the framework of general relativity were Einstein's, which has matter but no motion, and de Sitter's, which has motion but no matter. These are the only two possible static models — in which the average density of matter is the same at all places and times. Friedmann began considering nonstatic models in 1922, and they have been studied extensively since. Dr. Whitrow also treats the work of Eddington, in which a finite universe is the keystone; of Milne, whose universe has expansion as its fundamental feature; of Bondi and Gold and Hoyle, who consider time invariance a paramount axiom. The author's comparison of present-day cosmologies is both thoughtful and provocative.

The seventh chapter deals with the structure of galaxies of different types, and the last chapter with the age and evolution of the universe and of the objects within it. Current ideas on stellar and galactic evolution are reviewed, including Oort's views on galactic creation.

Dr. Whitrow's book has high merit for a number of reasons. The writing has quality — things are said not only correctly but attractively. This is among the most thought-inspiring books I have ever read, partly because of its subject matter and partly because of the wealth of ideas between its covers.

It is an account that should be useful for all who are involved in astronomy. A person whose interest is just awakening will find some of the going tough and demanding, with formulas appearing here and there, but he will gain an understanding of what cosmology is all about. On the other hand, an astronomer or indeed a cosmologist will welcome a coherent look at a subject which today is full of confusion.

Inevitably there are a few minor errors,

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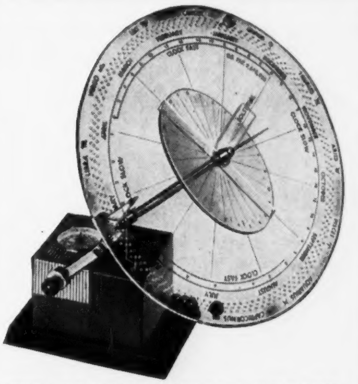

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From Stetson's *Manual of Laboratory Astronomy*, the following chapter is available as a separate booklet, at 50 cents each: I, Star Chart Construction.

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- TELESCOPE EYEPIECES
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The Book was reviewed in the January issue of SKY AND TELESCOPE.
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but only one major printing mistake is apparent. On page 125, in the discussion of Eddington's work, the total number of particles in the universe is given as 10^{-79}. The insertion of the minus sign makes this number deviate from the intended one by a factor of 10^{158}! But minor points aside, Dr. Whitrow's book will serve as a useful and exciting survey of man's attempts to find order in the cosmos.

STANLEY P. WYATT
University of Illinois Observatory

NOTE: A paperbound edition of this book has just been released by the Science Library of Harper and Bros. for $1.45.

MAN'S CONQUEST OF THE STARS

Pierre Rousseau. Jarrolds Publishers Ltd., 178-202 Great Portland St., London W. 1, England, 1959. 356 pages. 25s.

THE CONQUEST referred to in the title is not a physical but a figurative one. Nor is the book a speculative discussion of spaceflight, as its title might suggest. It is, rather, a history of astronomy and of man's growing knowledge of our situation in space.

Every popular author writing on astronomy has told part of the story; specialists have devoted years to the study of such small details as the naming of the telescope; and scholars such as Dreyer have made masterful syntheses. Why then another history of astronomy?

Beyond the fact that new people are always coming along to hear the story for the first time, Pierre Rousseau's work fully justifies its existence by the quality of its writing. Gallic clarity and wit illuminate the pages and make the book a delight to read. The translation is excellent, and only occasionally does the reader notice a thought that has not been well expressed in English.

The author has a special thesis to expound:

"The giant Anteus recovered his strength every time he touched the Earth. Conversely, as this book sets out to show, Man has seen his genius and power expand every time he renewed his contact with the starry sky. . . . The story of the gradual conquest of the skies is only another side . . . of the story of civilization."

In pursuit of facts to support his argument, Rousseau broadens his field to include astronomy's interactions with philosophy, commerce, religion, and technology. Whether or not he establishes the *necessity* of astronomy for our intellectual growth, he certainly documents fully the fact that the strands of astronomy are tightly intertwined with other lines of thought in the actual development of civilization. It seems nearly impossible to conceive how science would have developed if we could not see the sky.

Rousseau, not unnaturally, gives a disproportionate number of pages to French contributions. This becomes most striking when he admits that France's early-19th-century astronomers concentrated on celestial mechanics and positional astronomy, turning their backs on physical astronomy. Nevertheless, he then proceeds to give a good deal of space to the efforts of his countrymen in that period.

On the other hand, he does give full credit to others, particularly the British and, in the closing pages of the book, the Americans. His paean to the American millionaires who did so much to build our great institutions before World War II is a triumph of controlled envy.

Again and again in telling his story, Rousseau is forced to the exclamation that in astronomy avocation is everything. One after another, his characters start out to become clerks, sea captains, lawyers, or chemical engineers, and finish up by making important contributions in a science to which they have been drawn by pure love of its vistas and intricacies. There is much to inspire the amateur in the brief, concise biographies of the astronomers given in this book.

Careful research has obviously gone into this volume, but it is not to be viewed as a text. It is an exciting story told with great skill. One is not at all surprised that the author has been honored by the Académie Francaise for his science writing.

STEADMAN THOMPSON
Columbus Astronomical Society
Columbus, Ohio

THE UPPER ATMOSPHERE

H. S. W. Massey and **R. L. F. Boyd.** Philosophical Library, Inc., New York, 1959. 333 pages. $17.50.

PROF. H. S. W. MASSEY and Dr. R. L. F. Boyd have collaborated to write authoritatively about a field in which they have participated actively. They address not their fellow research workers nor the "popular" audience, but that in-between group composed of students, scientists in other fields, and those of us who are technically interested in space travel.

The treatment is quantitative though not highly mathematical. An example is the simple formula for the velocity, v, of a man-made satellite (by equating the centrifugal and gravitational forces)

$$v = (g_0\ R_0^2/R)^{\frac{1}{2}},$$

where g_0 is the gravitational acceleration at the surface of the earth, R_0 is its radius, and R is the satellite's distance from the earth's center.

The reader with an irresistible urge to check the authors' value of v (a little over 17,000 miles per hour) for a circular orbit 300 miles above the earth's surface finds himself frustrated, since elementary physics texts usually give g_0 in feet/second^2 or centimeters/second^2 and not in miles/hour^2. Of course, this situation is not the responsibility of the authors and is mentioned only to point out that the unit of distance used throughout the book is the mile. In the line drawings, it would have helped this reviewer if kilometer scales could have been added to those for miles.

After an introductory chapter on the physics of electricity and magnetism, of waves, and of atoms, molecules, and gases, the general properties of the atmosphere are outlined. Ensuing chapters include some operational details concerning balloons, rockets, and artificial satellites. There is a useful compilation of the first six satellites, Sputniks I, II, and III, Explorers I and III, and Vanguard I, accounting for all successful launchings through May 15, 1958. The Van Allen radiation belts were announced too late to be mentioned in this book.

Although the authors have given appropriate attention to the direct measurements of upper-atmosphere properties from balloons, rockets, and satellites, their treatment is largely concerned with the indirect methods that until recently were necessarily used as analytical probes. Included are discussions of work with sound waves and radio waves; measurement of the ozone content of the ozonosphere; studies of the airglow and the aurora; deductions from the study of magnetic records; and relationships among solar, magnetic, and ionospheric disturbances. One chapter takes up meteors, with particular emphasis on the use of radio observations, while another is devoted to cosmic rays.

Two general criticisms may be made. First, a few carefully selected references to review articles pertaining to each chapter would have been a big help to the serious student wishing to make a more detailed study. This need is only partially met by a bibliography of 20 titles. Second, the price is certainly too high to encourage wide distribution.

F. E. ROACH
Boulder Laboratories
National Bureau of Standards

NEW BOOKS RECEIVED

Close Binary Systems, *Zdenek Kopal,* 1959, *Wiley.* 558 pages. $16.75.

In this theoretical survey of eclipsing variable stars, Professor Kopal presents the detailed mathematical methods for the refined analysis of light curves. Among the many topics he discusses are the ejection of material from unstable components and evolutionary changes in close binaries.

Target for Tomorrow, *I. M. Levitt,* 1959, *Fleet.* 328 pages. $4.95.

A planetarium director tells in popular language about man's imminent venture into outer space, and describes possibilities and problems of lunar and planetary exploration.

The Individual and the Universe, *A. C. B. Lovell,* 1959, *Harper.* 111 pages. $3.00.

The impact of modern cosmology and recent astronomical advances is the theme of this volume, written by a prominent British radio astronomer for the 1958 Reith lectures.

Planetaria and Their Use for Education, *Miriam Jagger,* editor, 1959, *Cranbrook Institute of Science,* Bloomfield Hills, Mich. 205 pages. $3.50, paper bound.

Thirty-nine talks are published here that were given at the 1958 symposium on the educational uses of planetariums, held at the Cranbrook Institute of Science. They deal with teaching methods on various levels, planetarium construction, training of demonstrators, research uses of planetariums, and many other topics. The contributors include astronomers, educators, and planetarium operators and manufacturers. This publication is *Bulletin* 38 of the Cranbrook Institute.

College Physics, *Franklin Miller, Jr.,* 1959, *Harcourt, Brace.* 608 pages. $7.25.

Amateurs may find much useful information in this text, written mainly for introductory college courses in physics. Emphasis is on conservation laws, wave mechanics, field concepts, and particle theory.

Concise Dictionary of Science, *Frank Gaynor,* 1959, *Philosophical Library.* 546 pages. $10.00.

Brief, elementary definitions are given for some 5,000 technical terms used in physics and related sciences. The coverage of astronomical terminology is very meager.

From Euclid to Eddington, *Sir Edmund Whittaker,* 1958, *Dover.* 212 pages. $1.35, paper bound.

This reprint of a book first published in 1949 deals with the evolution of physical theories from the geometry of Euclid, through relativity and quantum mechanics, to Eddington's last work.

Our Earth, *Arthur Beiser,* 1959, *Dutton.* 123 pages. $3.25.

For laymen readers, an author-scientist describes our planet from its center to the outermost reaches of its atmosphere, including some International Geophysical Year discoveries.

Astronomical Photography at the Telescope, *Thomas Rackham,* 1959, *Faber and Faber,* 24 Russell Square, London W.C. 1, England. 232 pages. 36s.

Amateurs interested in taking their own photographs of solar system objects will find detailed instructions for every stage of the process in this book. Mr. Rackham describes the camera attachment he built for his 6-inch reflector, and explains exposure and darkroom techniques.

CORRECTION

The price of *Handbook for Observing the Satellites,* by Neale E. Howard, is $3.50, not $2.50 as stated on page 519 of the July issue.

Star Atlases and Books on Astronomy
New: THE OBSERVERS GUIDE........$2.95
Norton's STAR ATLAS........$5.25
Webb's ATLAS OF THE STARS........$6.50
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THE MOON, by Wilkins and Moore..**$12.00**
THE SUN, by G. Abetti........**$10.00**
THE PLANET VENUS, by P. Moore..**$3.00**
GUIDE TO MARS, by P. Moore........**$2.75**
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Book 1, **$5.00**; Book 2 **$6.00**; Book 3, **$7.00**
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1960 AMERICAN EPHEMERIS AND NAUTICAL ALMANAC........$4.00

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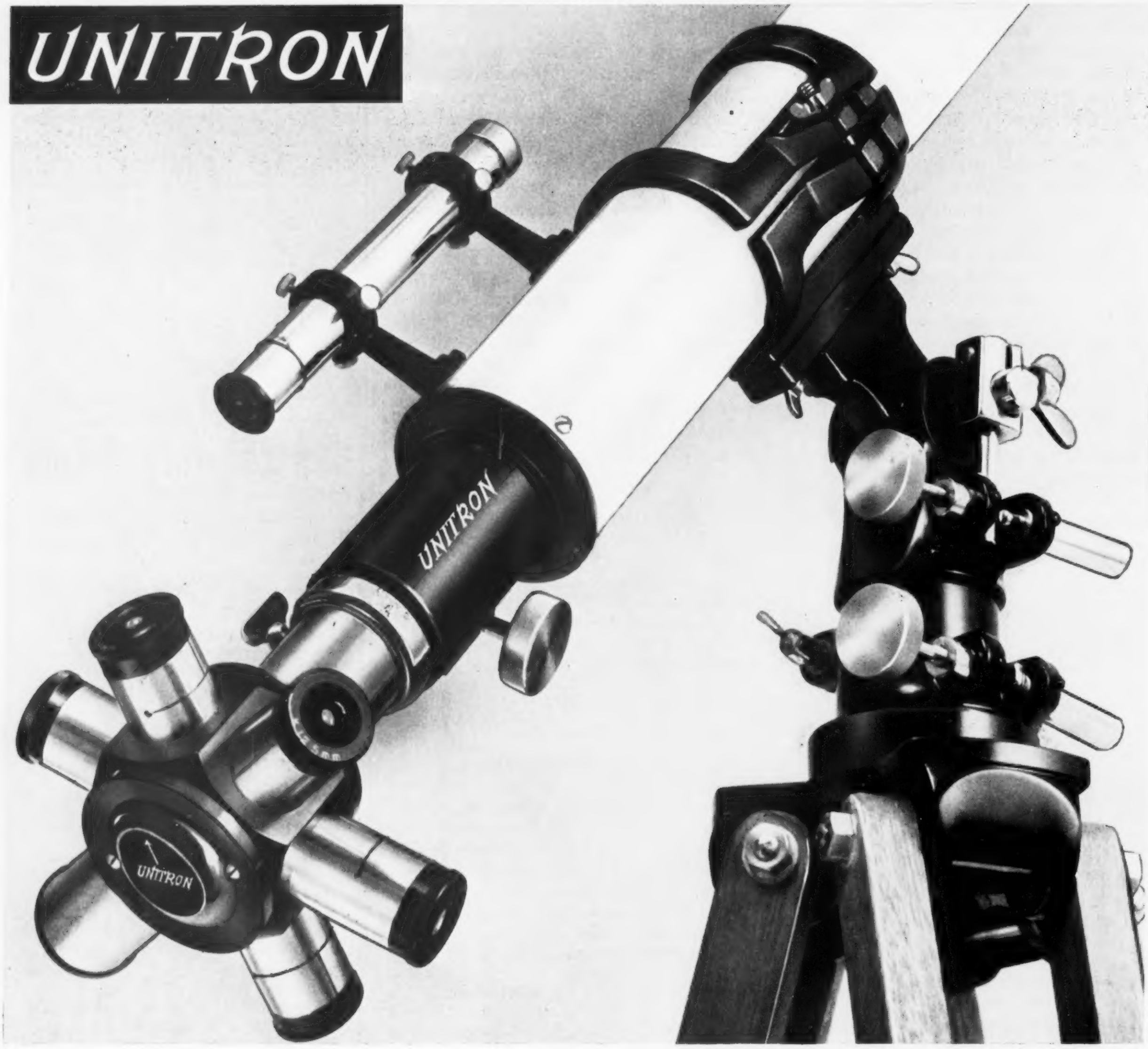

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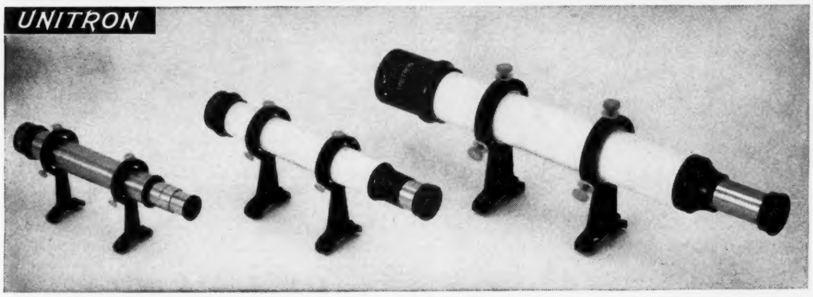

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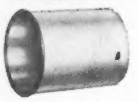

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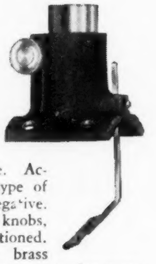

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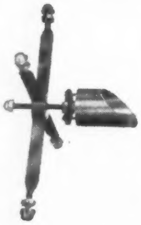
Diagonal Rod Cat. #SU-9R $1.00

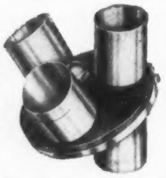
Four-Vane Diagonal Holders



Criterion 4-vane diagonal mountings are fully adjustable, will hold elliptical diagonals in perfect alignment. Made of brass, chemically blackened. Precision adjusting screws center flat and vary its angle so that primary and secondary mirrors can be set in perfect alignment. Thin vanes with special adjustable studs.

Cat. #	Minor-Axis Size	For Tubes	Price
S-51	1.25"	6½" to 7½"	$10.00
S-52	1.30"	6½" to 7½"	10.00
S-53	1.50"	8½" to 9½"	10.00
S-54	1.75"	9½" to 10½"	12.50
S-55	2.00"	11" to 11½"	14.95
S-56	2.50"	Specify tube I.D.	19.95

Revolving Turret



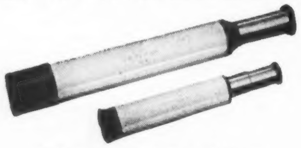
The Criterion Revolving Turret holds three eyepieces so that, as desired, the power of the telescope can be changed by merely turning the turret to a different ocular. Click stop insures positive and accurate positioning of each eyepiece. Turret holds eyepieces of standard 1¼" outside diameter. Fits into the holder of any refractor or reflector telescope that uses 1¼" eyepieces. Requires no alteration or adjustment and can be attached as easily as putting eyepiece into scope. Made of brass and aluminum with polished chrome-plated barrels.

Cat. #SRT-350 **$14.50**

Wide-Angle Erfle Eyepiece

Our 16.3-mm. Erfle wide-angle eyepiece has a 75° field. Astonishing wide-angle views. Coated. Highest precision and specifically designed for telescopic use. Chrome barrel. Guaranteed to be superior in every respect.

Cat. #SE-63 — 1¼" O.D.	$18.50
Cat. #SE-62 — 0.946" O.D.	$16.50



Achromatic Finder Scopes

Two models: 6x, 30-mm., and 10x, 42-mm. Coated achromatic air-spaced objective, cross-hairs, built-in duraluminum tube finished in white enamel, dewcap. Sliding focus adjustment. Can also be used as excellent hand telescopes for wide-field views of the sky. Fit Mount Bracket #SF-610.

6 x 30 Achromatic Finder	$12.50
10 x 42 Achromatic Finder	$18.00

Heavy-Duty Equatorial Mount

For 6" to 10" Scopes

Here is rock-steady viewing. Equipped with roller bearings for smoothest operation. 1½"-diameter shafts. Can be fitted with clock drive and setting circles. Oversize massive castings insure utmost stability. Saddle is 12" long. Legs are equipped with Tri-Lock arrangement. Adjustable for all latitudes. Over-all height 36". Clamps on both axes. Shipped by Express ready to use.

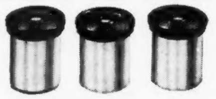
Cat. #SK-9 .... **$149.50** f.o.b. Hartford, Conn. Shipping weight 45 lbs.

Reflecting Telescope Mirror Mounts

Mounting the mirror to your scope correctly is most important. Criterion mounts are especially well designed, and are made of cast aluminum with brass mounting and adjustment screws. One section fits tube, other section holds mirror. Alignment accomplished by three spring-loaded knurled adjusting nuts. Outer cell designed to fit into or over your tube. Sufficient space left between the two cells. All drilled and tapped. Complete with holding clamps, springs, nuts, etc. Ready for use. Will prevent vibration and hold alignment once set. Will hold mirror without distortion of surface figure.

3"	$3.00	6"	$6.00
4"	3.50	8"	12.50
5"	4.00	10"	14.75

Complete Eyepieces



Finest quality. They are precision machined, mounted in standard 1¼" outside diameter barrels; ⅞" O.D. also available at no extra cost. Can be taken apart for cleaning. Designed to give sharp flat field clear to edge.

Huygens 18-mm. f.l. (¾")	$ 7.50
Kellner 9-mm. f.l. (⅜")	7.90
Kellner 7-mm. f.l. (9/32")	8.50
Kellner 12.7-mm. f.l. (½")	9.50
Orthoscopic 6-mm. f.l. (¼")	12.50
Orthoscopic 4-mm. f.l. (5/32")	14.50

Convert your present 35-mm. Camera with new Astro-Photo Adapter

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CPA-36 for 1¼" eyepiece holders	$19.00
CPA-37 for 4" standard Dynascopes	$17.50

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Catalog F, describing other accessories and parts, cheerfully sent on request. Satisfaction guaranteed, or money refunded. Send check, cash, or money order for immediate delivery.

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CONDUCTED BY ROBERT E. COX

A Simplified "Schmidt" Camera for Amateurs

When Bernhard Schmidt devised his coma-free reflector, he reasoned in three steps. First, if a spherical mirror is used with an aperture stop at its center of curvature, the stellar images obtained will be free of coma and astigmatism over a wide curved field.

Second, if the focal ratio is large, spherical aberration will be small enough to allow faultless photographs to be made. On the other hand, if the focal ratio is small, spherical aberration may become intolerably great.

Third, spherical aberration can be practically eliminated by replacing the simple aperture stop with a suitably figured aspheric correcting plate or lens. This made possible large fast cameras of wide-field performance formerly quite unattainable.

Careful study of the function of the correcting plate shows that under appropriate conditions it can be dispensed with, leaving an instrument of unequaled simplicity, yet of a performance entirely adequate for an amateur's photographic needs. Depending upon the kind of observing to be done, and considering speed, limiting magnitude, field, plate scale, sky light, and cost, for general purpose work the focal ratio will lie between f/4 and f/7.

With spherical aberration limiting the performance of such a simplified camera, it will be necessary to set a standard of permissible image size due to the amount of this aberration present in the system. The diameter *d* of the least circle of confusion of a star image can be calculated with sufficient accuracy for our purpose by the formula

$$d = 8a/N^2,$$

where *a* is the aperture in inches, *N* the focal ratio, and *d* is expressed in thousandths of an inch. The dependence of the effect of spherical aberration on the focal ratio, and to a lesser extent on the aperture, is evident.

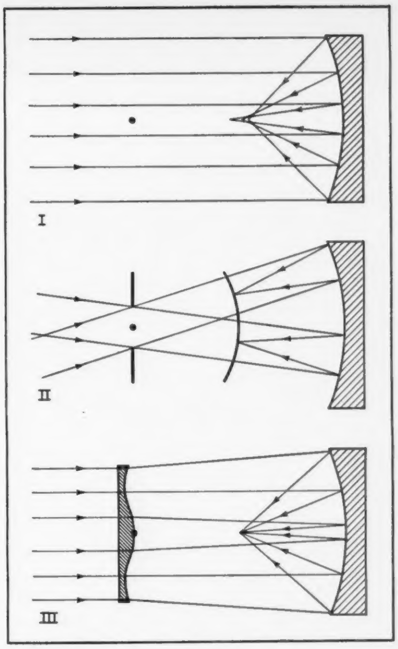
For photography, stellar images need not be as small as for visual observing. Diffusion effects in the emulsion, unsteadiness of a mounting, imperfect driving, thermal shifts of focus, guiding errors, and unsteady air, all combine to enlarge a star image. Therefore, attempts to obtain optical images smaller than a certain size are unwarranted. The only remaining question is: What is the practical limiting size?

A star image seldom is smaller than 0.004 inch at the prime focus of the 200-inch Hale reflector. In the *Amateur Astronomer's Handbook,* J. B. Sidgwick finds the optical image satisfactory if the combined effects of aberrations do not make it bigger than 0.0025 inch. Experienced photographer Jean Texereau, in his *How To Make a Telescope,* is content with 0.004 inch.

It seems correct to assume that if our spherical mirror, with an aperture stop at its center of curvature, is designed to give images no more than 0.002 or 0.003 inch across, any detectable imperfection in the photographic results will be from causes outside the optical system, and twice that image size will probably be quite tolerable. The following table, based on the formula above, lists the minimum focal ratios for various sizes:

MINIMUM FOCAL RATIO – *N*

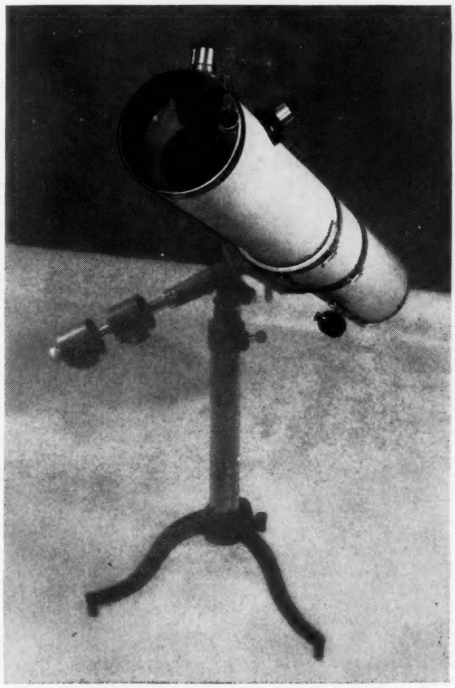
Aperture (inches)	*Image diameter d in inches* 0.002	0.003	0.004
3	3.5	2.9	2.5
4	4.0	3.3	2.9
5	4.5	3.7	3.2
6	4.9	4.1	3.5
7	5.3	4.4	3.8
8	5.7	4.7	4.0



Compare the light paths in: I, a simple spherical mirror; II, the simplified Schmidt design; and III, a conventional Schmidt with a correcting plate.

The simplified Schmidt camera has reasonable focal ratios for amateur use and gives very good optical performance, but the field is curved, as in any Schmidt instrument of the basic design. In small cameras of medium to long ratio (for example, 4-inch, f/6) a flat filmholder is still allowable, but otherwise it will be necessary to use a curved filmholder or a field-flattening lens. However, with as

The NEW **FI-NIS** Off-Axis Catadioptric Telescope



for the discriminating amateur astronomer

utilizes a Schmidt-type, off-axis correcting lens finished to the highest telescopic accuracy

To achieve unexcelled optical resolution, with image quality matching that which is theoretically possible for its aperture.

This new telescope, embodying a design never before commercially available, enables the realization of a rugged, closed-tube construction whose parts are solidly and permanently aligned — including the built-in wide-field finder.

Its 4¼-inch aperture is *entirely free* of obstructions — its image *completely achromatic.* The flawless color fidelity and brilliant contrast are striking at first glance — a result of its well-made off-axis construction. This is a *really different* telescope.

The price, without mounting, is presently $400.00 subject to quotation. Write us for detailed information.

Other products: **SOLA-FIL** — an unusual solar filter

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shallow a curved focal surface as one of these cameras will have, it should be relatively easy to bend the film without buckling it.

What can this simple instrument do that an ordinary paraboloidal reflector cannot? Assuming that a 0.004-inch image is acceptable, compare two cameras of similar light grasp and tube length, an 8-inch Newtonian of f/8 and an 8-inch uncorrected Schmidt of f/4, the latter having a 16-inch mirror.

The usable field of the Newtonian is confined by coma and astigmatism to a diameter of 1° 50′, and at the edges a tendency to image asymmetry is noticeable. The field of the spherical mirror camera with its simple aperture stop is limited only by the size of its plateholder. Keeping this below half the aperture, the field may be as wide as 6°, corresponding to 10 times the sky area covered by the paraboloid, and images will be evenly rounded throughout.

At the same time, the required exposure for an extended object, such as a comet, is little more than one-fourth as long. To match this speed with a Newtonian by altering its focal ratio from 8 to 4 would result in a further reduction of the useful field width, to just over 1°, or an area 1/30 of that handled by the Schmidt camera.

The simpler instrument even has some advantages over the conventional Schmidt with a correcting plate. Reflections at the latter waste light and may produce ghost images. Unless the plate is of special glass, it strongly absorbs ultraviolet light. The aperture can, of course, easily be increased to allow for those occasions when speed is more important than the highest image quality and evenness of field illumination. A 4-inch camera of f/5 will probably have a 6- to 7-inch mirror and can quickly be converted to a 6-inch of f/3.3, thus halving the exposure time on a faint extended object.

The work of building the simple Schmidt is easier. The upper half of the tube, which is required merely to keep the aperture opening somewhere near its theoretical position, may be of very light construction. It is even possible to have it completely removable for easy access to the filmholder.

After using the simple camera for a time, an amateur may wish to add a correcting plate to it, thereby obtaining a camera of unsurpassed performance. At the focal ratios listed above, the deviations on the correcting-plate surface are so small that in many instances it will be possible to polish them with flexible ring laps.

From the many possible designs, the following two have been chosen to have aberration circles no more than 0.002 inch at the curved focal surface. All dimensions are in inches:

Dimension	*Camera A*	*Camera B*
Aperture	4	6
Focal ratio	4	5
Diameter of filmholder	2	2½
Field in degrees	6	4½
Diameter of mirror	8(6)	11(9)
Focal length of mirror	16	30
Tube length	32	60

The ideal mirror diameter is given, but little would be lost if for economy and weight reduction the figures in parentheses were used.

L. A. JONES
G.P.O., Box S 1460
Perth, W. Australia

EDITOR'S NOTE: This article has been adapted from one appearing in the May, 1959, *Bulletin* of the Astronomical Society of Western Australia.

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(Starred items exclusive with The Astronomer Kit)

6-inch kit........................$15.00 ppd.
Also: 4¼-inch, $11.50 ppd.; 8-inch, $24.50 ppd.*

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Here is a combination of a Barlow and a particular ocular which gives outstanding results. It consists of our new Barlow and our 16.3-mm. (⅔″ focal length) Erfle eyepiece. While the Barlow was not specifically designed to work with this eyepiece, it does so to an astonishing degree. All images are sharp and hard to the very edge of the field.

The Barlow gives magnification up to slightly over three times that of the ocular alone. It is achromatic, coated, and mounted to the U. S. standard size of 1.250 inches.

The modified Erfle eyepiece has a field of 75 degrees with excellent eye relief. The combination gives the equivalent focal length of slightly under 6 millimeters. Many users state it is far superior to any shorter focal length ocular of equivalent magnification.

The Barlow sells for $16.00 postpaid, and the Erfle for $14.75 postpaid. Both are guaranteed to perform as stated above or money refunded.

ORTHOSCOPIC OCULARS—All hard coated, standard 1¼-inch outside diameter.

28-mm. .... $15.00 **10.5-mm. .... $16.25** **4-mm. $17.25**
16.3-mm. (Erfle) .... $14.75 **7-mm. .... $17.25** **Barlow 3x $16.00**

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Finished mirrors, mirror kits, spiders, elliptical flats, focusing devices, aluminizing.

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FACTS ABOUT THE PERFORMANCE OF REFLECTING TELESCOPES

and a note on refractors.

Many observers are familiar with the theoretical appearance of a star image in excellent seeing, as a "central disk" surrounded by a system of faint diffraction rings.

Below are some facts related to this, and which may, by a little thought, be applied also to the delineation of very delicate details on the moon and planets.

1. "Perfect" primary mirror and *no* diagonal mirror obstruction: 84% of the total light in the central diffraction disk.
2. "Perfect" mirror and 21%-diameter obstruction by diagonal mirror or compound secondary mirror: 76% of total light in central disk.
3. 1/8-wave mirror with 21%-diameter obstruction: 61% of total light in central disk.
4. Two-lens refractor above 5 inches aperture, corrected to resolve to Dawes' limit: 68% of light in central disk.
5. For refractors as characterized above, the chromatic aberration alone exceeds the Rayleigh limit, even if perfectly corrected spherically.

You may draw your own conclusions from the above. I have prepared some material dealing with practical aspects of obtaining maximum performance from excellent reflecting optics, for which new or interested observers are invited to apply. Included also are prices, terms, and descriptions of reflecting optics of uncompromising quality.

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EPOXY RESIN — A CEMENT FOR CERAMIC-TILE TOOLS

ABOUT three years ago I temporarily suspended work during the grinding of a 12½-inch, f/8.5 pyrex mirror. The tool was made of ceramic tiles embedded in portland cement, according to instructions given in this department by George F. Joyner in the January, 1949, issue of SKY AND TELESCOPE. Recently, when starting to shorten the mirror's radius of curvature with No. 80 carborundum, I discovered that time had caused the cement supporting the tiles to become brittle and crack in several places. As a result the tool's surface was flexible and worthless.

An adhesive was needed to fasten the ceramic tiles for another tool, this time directly on a supporting crown glass disk 12½" by 1". Placed in contact with the mirror's surface the tiles would conform closely enough to the existing radius, but there was a difference of ⅛" between the edge and center pieces due to the sagitta of the glass. A satisfactory cement would have to fill this difference in spacing between the flat crown glass and tiles without shrinking or expanding upon setting, and without pulling the lower tiles up to the glass by surface tension. The adhesive would need to be completely waterproof, possess a reasonable setting time, and adhere to glass and ceramic tile.

Epoxy resin possesses all of these properties to a remarkable degree. Mixed according to the following formula, there was about one hour in which to place an appropriate amount of cement on the backs of all of some 120 hexagonal tiles required for the 12½-inch tool. Within 48 hours it was possible to slide the tool off the mirror and start using it for rough grinding.

Formula

A. 1 part by weight of #820 Shell Epoxy Resin
   1 part by weight Terra Alba pigment

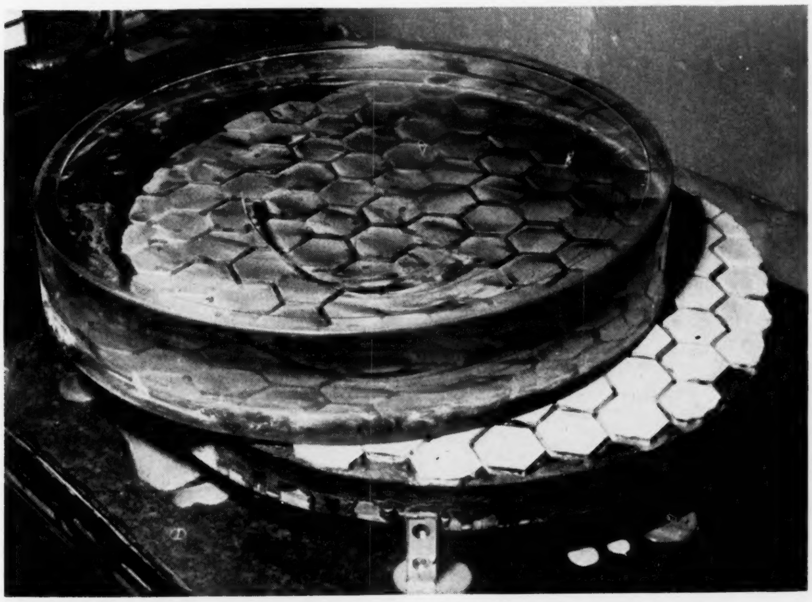
B. ⅕ part by weight Shell Curing Agent "U"

Mix A and B prior to using, the combination having a usable life of about one hour at 70° Fahrenheit. Component B is somewhat toxic and may cause inflammation if allowed to contact the skin. Handle with care and avoid breathing the fumes when mixing.

As epoxy resin forms a strong bond with glass, extreme precaution was taken to prevent its contact with the mirror surface. The glass face was coated with a light covering of Vaseline. Over this was placed a layer of thin polyethylene (cut from a dry cleaner's plastic bag), smoothed into close contact and carried down over the edge of the glass. A second coating of Vaseline was put on the plastic cover, and the tiles were placed in direct contact with this surface.

After the epoxy resin had been placed on the backs of the tiles, the crown glass was carefully centered over the assembly and brought into contact with the cement. A firm vertical pressure spread the resin until, viewed through the back of the glass, it was in even contact over all of the tile surfaces and the glass tool. Lateral movement was avoided, as some of the tiles might have been displaced. Tiles that are extremely close or touching can hold abrasive, which during subsequent grinding might come loose and cause light scratches.

My grinding stand is constructed of



Although the glass disk supporting them is flat, the ceramic tiles conform to the surface curvature of Bryant W. Pocock's 12½-inch mirror; they are held permanently in position by epoxy resin cement.

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ALUMINUM [illegible] OVERCOATED
CHROMIUM ALLOY

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4¼"	¾"	$ 6.00
6"	1"	$10.50
8"	1½"	$18.75
10"	1¾"	$33.65
12½"	2⅛"	$59.95

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Within the next few months, the writer will offer standard telescope mirrors for sale. These mirrors will be distinguished by their accurate figure of 1/40th to 1/50th wave length of sodium D light. More concisely, to a peak surface departure of 0.4 to 0.5 micro-inch.

Testing will be performed using the caustic test of Platzeck and Gaviola at a cost of $3.50 per square inch of surface plus blank. The maximum size will be 12½ inches for the time being.

Amateurs who are contemplating the need for such equipment, or the refiguring of existing mirrors, should address the undersigned, who offers whatever service can be rendered at this early date. A brief discussion of the Rayleigh limit and the caustic test is available for the asking.

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Aluminized with quartz over-coat

Fine annealed Pyrex. Minor- and major-axis tolerance, 45 degrees ± 5 minutes. Angular dimensions, +0%, −½%. Flatness, ⅛-wave-length sodium light. Surface quality, pitch polished, free of significant chips, scratches, pits, or bubbles.

Minor Axis	Thickness	Polished blank	Unpolished blank
1½″	½″	$ 8.00	$2.15
1¾″	½″	10.00	3.33
2″	½″	14.95	4.50
2⅜″	⅝″	17.95	5.40
2¾″	¾″	23.95	7.25

Discounts to quantity purchasers.

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Made by Jena Glass Works, Germany, each pair consists of one crown-glass blank, 1.516 refractive index for sodium light and 64.0 dispersion, and one flint-glass blank, 1.620 refractive index and 36.3 dispersion.

Diam.	Grade A	Grade B	Diam.	Grade A	Grade B
4″	$23.10	$12.10	6½″	$ 84.70	$46.20
4½″	29.70	15.90	7″	104.00	57.20
5″	38.50	20.90	7½″	242.00	—
5½″	52.80	28.60	8″	297.00	—
6″	63.80	35.20			

Grade A blanks are fine annealed and tested for striae — the best grade they make. Grade B are cast glass which may contain some fine striae.

Four formed steel tools cut to your radius specifications on order for approximately $30 in 5″ diameter to $75 in 8″ diameter.

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Solid cast aluminum, fully adjustable, painted, complete and ready to use. Shipped postpaid.

6″ mirror cell for 7″ or larger tube	$ 6.75
8″ " 9¼″ "	8.95
10″ " 11¾″ "	15.95
12½″ " 14½″ "	20.95

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CERIUM OXIDE

Optical grade for fast-polishing action. Use 3 or 4 ounces for 6″ mirror. In sealed plastic bag.
25¢ per ounce

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This fast-cutting aluminum oxide has shaped grains that bite into the work for minimum grinding effort. It is tougher and stands up longer under severe usage. Excellent for both hand- and machine-grinding. Individually packaged quantities for shipment.

Grain size	5 lbs.	25 lbs.	50 lbs.	100 lbs.
#60	$2.25	$10.00	$16.00	$25.00
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#220	2.85	13.00	23.00	40.00

All quantities shipped express collect.

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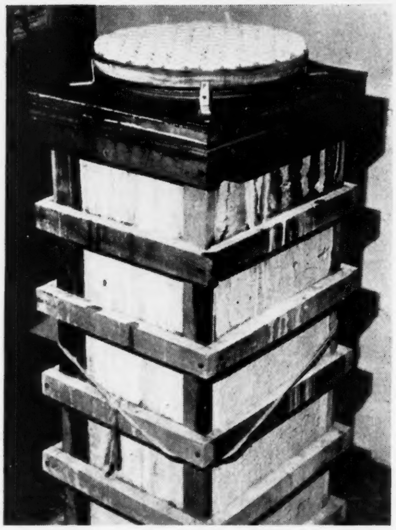

The grinding stand designed by Dr. Pocock is in six sections, holding the ceramic-tile tool at working height.

six blocks of concrete, each measuring 6″ by 12″ and weighing 75 pounds, totaling three cubic feet of concrete or 450 pounds. They are held together by furring strips with a top capped by ¾″ plywood, wood boards, and finally by ¼″ masonite. The working surface is about 40″ above the floor. All wood likely to warp was coated with spar varnish. The pier is not fastened to the floor, as it is massive enough to resist a lateral thrust of nearly 68 pounds.

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810 Sunset Lane
East Lansing, Mich.

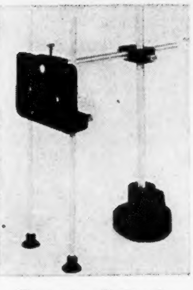
MICROSCOPE OBJECTIVES FOR RADIUS TESTING

SEVERAL amateurs have found difficulty in operating the radius tester described on page 309 of the April, 1958, issue, because they have used microscope objectives of too short a focal length. The highest-power objectives generally available are designed for oil-immersion microscopy, and the image plane is too close to the front element for radius testing.

The tester will work well with an objective of not over 20x, having a numerical aperture (N.A.) of 0.50 and a focal length of eight millimeters. It should have a cone angle of f/1.2 (at the radius of curvature) using a standard microscope tube length, and it should adequately cover the surface of an f/15 Gregory-Maksutov correcting lens.

The cone of light need not cover the test surface completely, however. Sufficiently accurate readings can be made if 80 per cent of the surface is illuminated, provided it is nearly spherical. A microscope objective with too long a focal length will illuminate only a small central portion, and this restricted area could give a false result. R. E. C.

UNMATCHED VALUES IN TELESCOPE ACCESSORIES



Three-way adjustment accommodates all situations.

ANOTHER FIRST!
THE COAST INSTRUMENT

CAMERA MOUNT

We have had hundreds of requests for a camera mount to adapt any camera instead of a one-purpose astro-camera. Our solution is shown in the illustrations. Constructed of aluminum castings and heavy main shafting, maximum rigidity is attained. All accessory hardware of brass. All surfaces, other than shafting, are handsome, chip-resistant black crackle. This camera mount will accept any size, weight, or length camera.

$35.00, f.o.b. Long Beach, California.

$199.50
PROMPT DELIVERIES

NEW! 6" PATHFINDER TELESCOPE

- Our popular PATHFINDER mount, with 1½" SOLID-STEEL shafting, accurate latitude adjustment, detachable legs, and semirotatable tube saddle, gives lightweight portability, with no sacrifice of complete rigidity.
- Durable aluminum tube, dull black inside, beautiful white enameloid outside.
- Regular TRECKER mirror cell and spider, the same as used in our more expensive models.
- f/10, ⅛th-wave primary mirror, exquisitely figured by our outstanding optical craftsmen from selected Pyrex blanks, and guaranteed to resolve to Dawes' limit.

As with all TRECKERSCOPE products, only highest possible quality components are used.

- HELAJUST eyepiece focusing mount features quick, snap focusing, coupled with complete, helical fine focusing.
- 6x, all-metal, wide-angle finderscope, helical focusing, with crosshairs. Three-way adjustment on mount.
- Oculars: 28-mm. achromatic Kellner, 12.5-mm. Huygens. As the HELAJUST accepts all 1¼" O.D. standard oculars, many other focal lengths are available for purchase to provide up to 400x.

Completely portable, yet ultra-solid for perfect viewing.

TRECKER clock drives and setting circles may be easily added at any time.

MIRRORS, GUARANTEED 1/20th WAVE, OR BETTER, PARABOLIC, FROM COAST'S OWN OPTICAL SHOP, ALUMINIZED AND QUARTZ OVERCOATED

	6" f/10	6" f/8	8" f/7.5 or f/6	10" f/7.5 or f/6	12½" f/7.5 or f/6
1/20th WAVE		$72.50	$105.00	$235.00	$332.50
1/10th WAVE		$62.50	$95.00	$195.00	$282.50
1/8th WAVE	$47.50				
REFIGURING, NO CHANGE IN YOUR OWN FOCAL LENGTH, 1/20th WAVE:					
1/20th WAVE		$39.50	$65.00	$110.00	$175.00
1/10th WAVE		$37.50	$55.00	$80.00	$125.00

ALL ABOVE PRICES INCLUDE MATCHING ELLIPTICAL DIAGONALS AND ALUMINIZING WITH QUARTZ OVERCOATING.

TREAT YOURSELF TO THE FINEST — Words alone cannot express the superb quality of COAST mirrors — they will positively amaze you with their "out-of-this-world" resolving power. This we guarantee you! Dawes' limit so easily!

TELESCOPE OPERATING MANUAL
by Raymond Dudley

Explains amateur telescope operation, including setting circles, sidereal time, alignment, orientation. Shows 52 most beautiful objects in sky and how to find them as well as general "how-to-observe" instructions. 44 pages of information every amateur needs.

$1.00 postpaid.

HELAJUST FOCUSING MOUNT

Now at a new low price, but unexcelled in construction. Both push-pull for coarse adjustment, and helical movement for fine, precise focusing. Beautifully finished in black crackle and satin chrome, with a total extension of main tube and drawtube of 6", and engineered to fit all sizes of tubes without modification. Has single-vane-spider holding boss for those desiring this method of using diagonal. Guaranteed far superior to any other low-priced focusing mount, or **money back.** (Takes 1¼" eyepieces.) **$9.95**

ORTHO-STAR
16.0mm

ORTHO-STAR OCULARS

DUST SEALED — ALL COATED
BEAUTIFUL FINISH

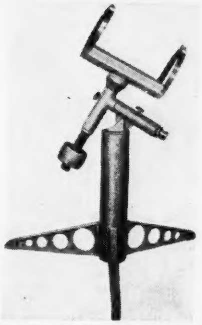
Guaranteed to be the finest you ever used— or return for full refund! Outstanding features: wide flat field, sharp to the very edge; extra-long eye relief; parfocalized for easy change of power; sealed-in optics, never need interior cleaning; hard coated, magnesium fluoride; boldly marked for easy identification; striking chrome and black-velvet finish, beautifully machined, 1¼" O.D.

ORTHO-STAR oculars are available in the following focal lengths, giving, for example, the indicated powers when used in conjunction with an 8" f/8 mirror: 27 mm.—61x; 20 mm.—81x; 16 mm.—102x; 10 mm.—163x; 7 mm.—233x.

$19.50 each ppd.

NOW AVAILABLE: 20-MM. ERFLE ORTHO-STAR OCULAR, 66°.7 apparent field. **$29.50 each ppd.**

USE OUR EXTENDED PAYMENT PLAN ON ALL SCOPES AND MOUNTS



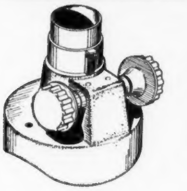
TRECKER-PATHFINDER EQUATORIAL MOUNT

$74.50 complete

This mount will accommodate 4-inch to 8-inch telescopes. Specify your tube size when ordering.

Standard 36-inch height — massive 1½-inch steel shafting, in oil-impregnated bronze bearings.

This amazing EQUATORIAL MOUNT is just what the doctor ordered for mounting that homemade telescope you labored so hard to finish. Now you can purchase a beautifully constructed, highly rigid equatorial mount, COMPLETE, for your own telescope as economically as if you had built it yourself. This terrific mount is made entirely of metal; all of the moving equatorial parts are polished to work with maximum ease. Legs, head, and counterweight are all removable for easy storing. The saddle allows complete rotation of your tube. One of the more important features in this mount is that the polar axle is extended for ease in attaching a clock drive and/or setting circles, which may be added at any time. The TRECKER-PATHFINDER mount also has a beautiful, chip-resistant finish. Taking all of these unusual features into consideration, this is truly one of the best DOLLAR-FOR-DOLLAR values.



HYDRO-GLIDE Precision Focusing Device

Coast Instrument's own "Hydro-Glide" (type formerly referred to as "rack and pinion"). Now you can have WHISPER-SMOOTH control with absolutely no high and low spots as geared units have. This has never before been available in **any** focusing mount. Standard in appearance, yet utilizing an entirely **new** concept. We guarantee you will be astonished at its unbelievable superiority. If this isn't the absolute "smoothest," **return it for full refund.** **$18.50 patent pending**

MIRROR CELLS

Skeleton type

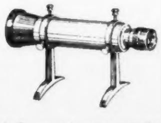
6"	**$6.95**	10"	**$17.95**
8"	**$10.95**	12½"	**$21.00**

4-VANE SPIDERS

6"	**$11.50**	10"	**$14.95**
8"	**$11.50**	12½"	**$16.95**

SEND FOR OUR NEW 68-PAGE CATALOG showing many of the other telescope items manufactured or distributed by COAST INSTRUMENT. It includes our treatise, "WHAT YOU SHOULD KNOW, LOOK FOR, AND DEMAND, BEFORE BUYING **ANY** TELESCOPE," an impartial, informative article that will give you information you've probably been looking for to help make up your mind as to just what telescope you should buy!

TRECKER FINDER



7x, 50-mm. objective, helical focusing, with mounts and crosshairs. Same as used on TRECKERSCOPES. **$18.50**

Send for Coast Instrument's Professional MIRROR CLEANING KIT. **$2.35 ppd.**

All prices, unless otherwise indicated, are at our warehouse in Long Beach, California, from where shipping charges will be added, and are subject to change without notice. Nominal crating charge added for all telescopes and mounts. California residents: Add 4% sales tax to all prices. NOW APPOINTING DEALERSHIPS . . . INQUIRIES INVITED.

TRECKERSCOPES ARE CUSTOM MADE IN AMERICA BY PROFESSIONAL OPTICIANS AND ENGINEERS.

COAST INSTRUMENT, INC.

"IN OPTICS SINCE 1933"

4811 Long Beach Blvd., Long Beach 5, Calif.
Phone: GArfield 2-3411 or NEvada 6-7683

how to use
YOUR
TELESCOPE

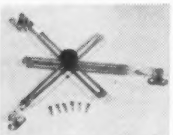
HELPFUL NEW BOOK for the AMATEUR

"HOW TO USE YOUR TELESCOPE"

A down-to-earth introduction to astronomical telescopes and the stars. Clear, simple language — profusely illustrated. Contains moon map — diagrams. Tells how to select and use telescope — all about power, mounts, eyepieces, collimation, Barlow lenses — guide to stars and planet observation.

Stock #9055-Y....32 pages............Only 60c ppd.

ADJUSTABLE TRIPOD BRACE



Protect your telescope, camera, or other instrument. This metal brace fastens to almost any tripod. Keeps tripod legs from spreading and causing telescope to fall. Each slotted metal arm is 9¾" long, ⅝" wide. 6 chrome-plated wood screws are included. Bakelite locking knob and wing nut included for quick locking in any position. Can be used on metal tripod legs by drilling legs and using self-tapping screws.

Stock #50,232-Y..........................$2.00 ppd.

Ideal for Beginners . . . STARMASTER ASTRONOMY SET!

STARMASTER
ASTRONOMY SET

Bring the thrills and wonders of outer space right into your home with this fascinating, educational Astronomy Set. De Luxe, 37-piece Set includes separate film projector and action pictures of a trip to the moon, from blast-off to return. Exciting views of the moon, planets, comets, distant galaxies, sun explosions, star clusters, other space wonders.

Also star projector and constellation projector (each approx. 4½" high). Projectors show many great constellations and stars, outline forms of Big Bear, Sagittarius, Southern Cross and others, for easy identification.

Also includes 10x telescope (single-element lens, meniscus, nonachromatic) with 1" aperture, suitable for viewing the moon.

Power source, flashlight pointer, and instructions included. Lower-priced Junior Set with single projector also available, but without telescope.

Stock #70,234-Y....De Luxe.............$10.00 ppd.
Stock #70,233-Y....Junior...............$ 5.00 ppd.

TELESCOPE ROLL-FILM CAMERA

This model uses rolls of #127 film. Picture area will be a circle 1-9/16" in diameter.

The advantage of this model is the ease of using roll film. With each camera you get a piece of ground glass. Before loading film in the camera, you focus the telescope. Then lock it in this position. For positions other than infinity, you can scribe a mark on your tube.

Stock #70,182-Y.................................$29.50 ppd.

SHEET-FILM CAMERA

Uses sheet film 2¼" x 3¼" size. Camera box size is 3" x 4" x 5".

Stock #70,166-Y.................................$39.50 ppd.

ASTRO COMPASS and STAR FINDER

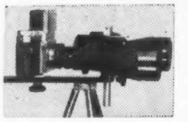
Gov't. Cost $75 — Price $14.95 ppd.

Determines positions of stars quickly. Shows various celestial co-ordinates. An extremely useful star finder which can be rotated through 60° angles along calibrated degree scale. Has single eye lens with viewing stop, two spirit levels for aligning, tangent screw with scale for fine precision readings, azimuth scale graduated in two-degree intervals, adjustable tilting azimuth scale for angle reference of stars on distant objects. War surplus. Gov't. cost $75.00. Instructions, carrying case included.

Stock #70,200-Y...................Only $14.95 ppd.

NEW BINOCULAR-TO-CAMERA HOLDER

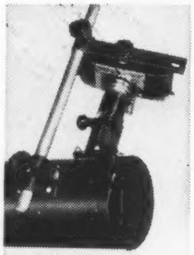
For Exciting Telephoto Shots



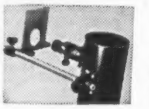
Bring distant objects 7 times nearer with a 35-mm. camera, 7 x 50 binocular, and our NEW BINOCULAR-TO-CAMERA HOLDER. Ideal for photographing the coming October eclipse of the sun, star clusters, the moon, as well as cloud formations, wild life, vistas. Camera and binocular attach easily. Use any binocular or monocular — any camera, still or movie. Take color or black-and-white. Attractive gray crinkle and bright chrome finish, 10" long. Full directions for making telephotos included.

Stock #70,223-Y.........................$11.50 ppd.

Take Pictures Through Your Telescope with the EDMUND CAMERA HOLDER for TELESCOPES



Bracket attaches permanently to your reflecting or refracting telescope. Removable rod with adjustable bracket holds your camera over scope's eyepiece and you're ready to take exciting pictures of the moon. You can also take terrestrial telephoto shots of distant objects. Opens up new fields of picture taking!



SUN PROJECTION SCREEN INCLUDED

White metal screen is easily attached to holder and placed behind eyepiece. Point scope at sun, move screen to focus . . . and you can see sunspots!

All for the low, low price of $9.95

Includes brackets, 28¾" rod, projection screen, screws, and directions. Aluminum . . . brackets black crinkle painted.

Stock #70,162-Y...................................$9.95 ppd.

Send check or money order — Money-back guarantee.

Mounted Ramsden Eyepieces

Standard 1¼" Diameter

Our economy model, standard-size (1¼" O.D.) eyepiece. We mounted two excellent quality plano-convex lenses in black anodized aluminum barrels instead of chrome-plated brass to save you money. The clear image you get with these will surprise you. Directions for using short focal length eyepieces are included with both the ¼" and ½" models.

Stock #30,204-Y....¼" focal length....$4.75 ppd.
Stock #30,203-Y....½" focal length....$4.50 ppd.

"TIME IN ASTRONOMY" BOOKLET

By Sam Brown. All about various kinds of time, contains sidereal timetable. How to use single- and double-index setting circles, how to adjust an equatorial mount, list of sky objects. Also includes 7" paper setting circles and stripes suitable for cutting out and mounting on plywood. Wonderfully illustrated.

Stock #9054-Y............................60c ppd.

ASTRONOMICAL TELESCOPE MIRRORS

Polished, Aluminized, and Over-coated

SPHERICAL MIRRORS

No.	Diam.	F.L.	Thickness	Price
30,219-Y	3"	18"	⅜"	**$5.95 ppd.**
50,082-Y	3"	30"	⅜"	**7.65 ppd.**
50,051-Y	4¼"	45"	⅝"	**15.00 ppd.**
70,168-Y	6"	72" (Pyrex)	1"	**30.00 ppd.**

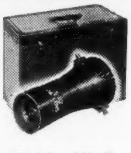
PARABOLIC MIRRORS (Pyrex)

No.	Diam.	F.L.	Thickness	Price
5002-Y	6"	48"	1"	**$59.50 ppd.**
85,069-Y	8"	64"	1⅜"	**89.00 f.o.b.***
85,070-Y	10"	80"	1¾"	**179.00 f.o.b.***
85,071-Y	12½"	100"	2⅛"	**275.00 f.o.b.***

*f.o.b. Barrington, N. J.

SALE! TERRIFIC WAR-SURPLUS BARGAINS!

AERIAL CAMERA LENSES



Big variety . . . at a fraction of Gov't. cost! f/6, 24" f.l., with diaphragm and lens cone. Used. Weight 25 lbs.

Stock #85,059-Y..$39.50 f.o.b. Utah

Same as above, but new. Weight 25 lbs.

Stock #85,060-Y..$59.50 f.o.b. Utah

f/8, 40" f.l., no mount or shutter. Weight 6¼ lbs.

Stock #70,186-Y.......................$49.50 ppd.

f/5.6, 20" f.l., telephoto with shutter and diaphragm. Weight 6¼ lbs.

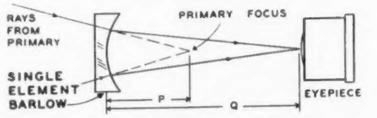
Stock #70,187-Y.......................$65.00 ppd.

f/4.5, 6⅜" f.l., with shutter and diaphragm. Weight 1 lb., 6 ozs.

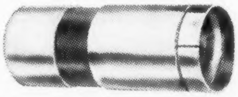
Stock #70,189-Y.......................$24.50 ppd.

These lenses are being successfully used for wide-aperture Moonwatch telescopes to see the small and fainter satellites. For eyepiece use our GIANT ERFLE.

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER WITH A BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q.



Beautiful chrome mount. We now have our Barlow lens mounted in chrome-plated brass tubing with special spacer rings that enable you easily to vary the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing, then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Two pieces provided, one for regular focal length eyepieces and one for short focal length ones.

Stock #30,200-Y Mounted Barlow lens......$8.00 ppd.

UNMOUNTED 3X BARLOW LENS

These lenses are made for telescopes that have smaller diameter eyepieces than the standard 1¼" size. Mount one between the eyepiece and objective, and triple your power. Instructions included. Single-element lens, focal length −1-5/16", unmounted.

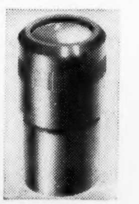
Stock #30,185-Y....0.932" diam...........$3.50 ppd.
Stock #30,328-Y....0.912" diam...........$2.50 ppd.

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our telescopes, polished and aluminized, lenses for eyepieces, and diagonal. No metal parts.

Stock #50,074-Y.......................$16.25 ppd.

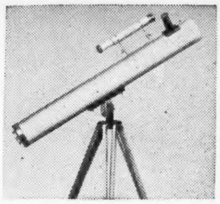
WAR-SURPLUS TELESCOPE EYEPIECE



Mounted Kellner Eyepiece, Type 3. Two achromats, focal length 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for most types of telescopes. Gov't. cost $26.50.

Stock #5223-Y........$7.95 ppd.

EDMUND SCIENTIFIC CO.



3-inch Astronomical Reflector

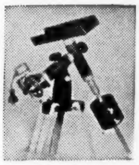
60 to 180 Power
An Unusual Buy!

Assembled — ready to use! See Saturn's rings, the planet Mars, huge craters on the moon, star clusters, moons of Jupiter, double stars, nebulae, and galaxies! Equatorial-type mounting with locks on both axes. Aluminized and over-coated 3"-diameter f/10 primary mirror, ventilated cell. Telescope comes equipped with a 60x eyepiece and a mounted Barlow lens, giving you 60 to 180 power. A finder telescope, always so essential, included. Sturdy, hardwood, portable tripod.

FREE with Scope: Valuable **STAR CHART** plus 272-page **"HANDBOOK OF THE HEAVENS"** plus the book **"HOW TO USE YOUR TELESCOPE."**

Stock #85,050-Y..................................$29.95 ppd.

EQUATORIAL MOUNT and TRIPOD with CLOCK DRIVE



Heavy-duty mount. Drive operates on 110-volt, 60-cycle, a.c. house current. Follows motion of stars smoothly. 32" tripod legs included.

Stock #85,081-Y.....$76.50 f.o.b. Barrington, N. J.

Same mount as above, without clock drive, for 8" or smaller reflectors and for 4" or smaller refractors.

Stock #85,023-Y..... New Low Price.....**$39.50** f.o.b. Barrington, N. J.

Same mount as above, with 4" pipe coupling, no tripod, for attaching to permanent 4"-pipe telescope support set in ground.

Stock #85,100-Y......$39.75 f.o.b. Barrington, N. J.

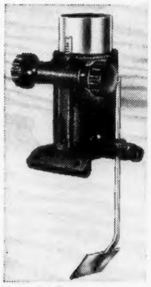
4" COUPLING only, without mount, for use with your own heavy-duty mount.

Stock #70,231-Y.......$11.00 ppd.

MOTORIZED CLOCK DRIVE (by itself) easily attached to your own mount. Instructions included.

Stock #50,198-Y........................$36.95 ppd.

Rack & Pinion Eyepiece Mounts



Real rack-and-pinion focusing with variable tension adjustment; tube accommodates standard 1¼" eyepieces and accessory equipment; lightweight aluminum body casting (not cast iron); focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50,077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50,103-Y and 50,108-Y are for refractors and have focus travel of over 4". Will fit our 2⅞" I.D. and our 3⅞" I.D. aluminum tubes, respectively.

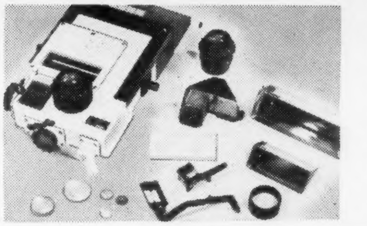
For Reflectors

Stock #50,077-Y (less diagonal holder) $8.50 ppd.
Stock #60,049-Y (diagonal holder only) 1.00 ppd.

For Refractors

Stock #50,103-Y (for 2⅞" I.D. tubing) 12.95 ppd.
Stock #50,108-Y (for 3⅞" I.D. tubing) 13.95 ppd.

SPECIAL SALE OF OPTICAL PERISCOPES



We made a lucky buy so here is another famous Edmund war-surplus bargain. It is a $500.00 tank periscope with over $200.00 worth of optics in it for only $18.00 postpaid. At one spot, you look through and see up and out of the prisms at unit power; or you can look through the built-in telescope system and see a wide-angle view at 6x. Simply remove the top prism and you have an 11°.3 6-power satellite telescope. *Brand new in original packages.* Over-all size is 14" long by 7" wide by 2½" deep.

Now just for the bit of work involved in disassembling, you get a treasure-trove of precision optical parts for only $18.00. Glance at this list of parts and you'll realize what a value we are offering. You get a wide-angle Erfle eyepiece with a full 68° field and 1¼" focal length. This is the same eyepiece used in Moonwatch telescopes, our Stock No. 5160. Also included are a 38-mm.-diam. collimator lens, 131-mm. focal length; 48-mm.-diam., mounted, coated objective lens, 189-mm. f.l.; prism cluster containing two light flint glass right-angle prisms (A, 41-mm.; B, 91-mm.; C, 64-mm.; and A, 41-mm.; B, 57-mm.; C, 40-mm.); two mounted right-angle prisms (A, 23-mm.; B, 34-mm.; C, 23-mm.; and A, 40-mm.; B, 42-mm.; C, 30-mm.); two silvered tank prisms (A, 102-mm.; B, 53-mm.; C, 38-mm.; and A, 167-mm.; B, 69-mm.; C, 49-mm.). (*See page 80 of our catalog for explanation of these prism sizes.*) Also some other optical elements and reticles. Every amateur will find this a real value. Don't wait — order today. The last time we had these they sold for $30.00 — now on sale at only $18.00.

Stock #70,227-Y..$18.00 ppd.

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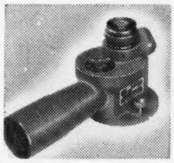

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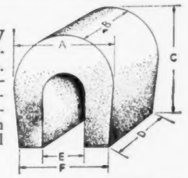

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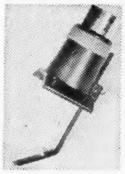

Here is an economical plastic slide-focus eyepiece holder for 1¼" O.D. eyepieces. Unit includes 3"-long chrome-plated tube into which your eyepiece fits for focusing. Diagonal holder in illustration is extra and is not included.

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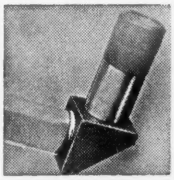

For comfortable viewing of the stars near the zenith or high overhead with refracting telescopes using standard size (1¼" O.D.) eyepieces, or you can make an adapter for substandard refractors. Contains an excellent high-quality aluminized right-angle prism. The tubes are satin chrome-plated brass. Body is black wrinkle cast aluminum. Optical path of the system is about 3½".

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Here is an exciting bargain. We have obtained a large lot of these eyepieces reasonably — so down goes the price to $9.95 for a real sale. Lens system contains 3 coated achromats over 2" in diameter. Gov't. cost over $100.00. Brand new, weight 2 pounds. The value will double when this lot is all sold, and triple and quadruple as years pass. If we didn't need to reduce our inventory, we'd be tempted to hold onto these eyepieces. Their wide apparent field is 65°. The focal length is 1½". Lenses are in a metal cell with spiral threads; focusing adapter with 32 threads per inch is included; diameter is 2-11/16". If you don't order now and you miss out on a hundred-dollar eyepiece for only $9.95, you can't say that we didn't try to impress you with its value. You can make some super-duper finders with these eyepieces. They are also ideal for rich-field telescopes, which are becoming more popular daily, particularly in the Sputnik age.

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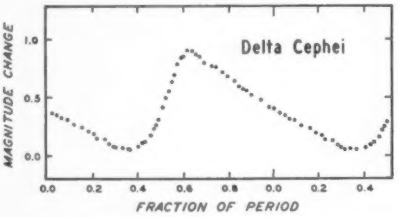
DELTA CEPHEI

AT this season, when Cepheus is high in the sky during convenient evening hours, the amateur observer can easily watch the rhythmic light changes of Delta Cephei, prototype of the Cepheid variables, an important class of pulsating stars.

As the visual brightness range is from magnitude 3.8 to 4.6, no optical aid is needed, but binoculars are useful for making out-of-focus comparisons with neighboring stars. Delta forms a small triangle with Zeta and Epsilon Cephei, stars that are approximate matches for the variable at maximum and minimum, respectively.

Delta runs through its cycle in 5.37 days, about a third of this time being spent in brightening. Try watching it on successive nights, each time estimating its brightness on a scale of 10 = Zeta to 0 = Epsilon. Plotting these estimates against the dates will give a light curve of this famous star, which was first detected as a variable in 1784 by an English amateur, John Goodricke.



The photovisual light curve of Delta Cephei by A. J. Wesselink.

About 41 seconds of arc from Delta Cephei is a companion star of magnitude 7. They form an easy double for even very small telescopes.

OCTOBER METEORS

This year the waning gibbous moon will interfere with observations of the Orionid meteor shower, which occurs for about 10 days, from October 15th to 25th. Under more favorable conditions, some 25 swiftly moving meteors per hour may be seen at this shower's peak. On the date of maximum, October 21st, the radiant is located approximately 10 degrees northeast of Betelgeuse.

The Taurid shower begins in late October and reaches maximum on November 6th, when about 15 meteors may be counted in an hour.

There is some possibility of a return this year of the Giacobinid meteor shower, which produced the great displays of 1933 and 1946. According to the *Observer's Handbook* of the Royal Astronomical Society of Canada, the earth will cross the orbit of Comet Giacobini-Zinner (see page 614, September issue) about 22 days ahead of the comet, very early in the morning on October 10th. Hence, if a shower occurs, it should be visible on the night of October 9-10, at any time between midnight and 7 a.m. Eastern standard time.

However, as pointed out in the *Handbook* of the British Astronomical Association, since the earth crosses ahead of the comet, and since perturbations by Jupiter in 1956 and 1957 have somewhat altered the orbit, possibly not even a minor shower will be seen. It is suggested, however, that all meteor observers maintain a vigil on this night. W. H. G.

MINOR PLANET PREDICTIONS

Elektra, 130, 9.7. October 19, 3:39.9 −16-04; 29, 3:34.4 −17-34. November 8, 3:27.4 −18-35; 18, 3:19.6 −19-00; 28, 3:12.4 −18-47. December 8, 3:06.7 −18-00. Opposition on November 15.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0ʰ Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

OCCULTATION PREDICTIONS

On Tuesday morning, October 20th, the 18-day-old moon will occult the 1st-magnitude star Aldebaran. Early risers on the west coast of the northern United States and of Canada can watch the star vanish at the moon's bright edge during morning twilight, around 6:10 a.m. Pacific standard time. Emersion will occur some 40 minutes later. For eastern observers, the sun will be well above the horizon when the star is hidden at about 9:22 a.m. Eastern standard time.

The event will provide an opportunity to view a star telescopically by day, taking advantage of the moon as a reference point. Although a small telescope will do, it should be carefully focused and the sky must be quite clear.

October 5-6 **Theta Librae** 4.3, 15:51.5 −16-36.6, 4. Im: **C** 0:10.7 −0.9 −1.7 113; **D** 0:01.3 −0.9 −1.4 101; **E** 23:53.5 −1.3 −1.3 104.

October 19-20 **Alpha Tauri** 1.1, 4:33.6 +16-25.7, 18. Im: **B** 14:21.6 +0.4 −1.8 115; **D** 14:27.7 +0.4 −2.2 126; **E** 14:44.9 +0.9 −4.3 155; **I** 14:09.5 −0.6 −4.2 144. Em: **E** 15:09.4 −0.8 +1.8 204; **I** 14:50.1 −1.3 +1.3 211.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the British *Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard-station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo,** lat. **L**) within 200 or 300 miles of a standard station (long. **LoS,** lat. **LS**). Multiply **a** by the difference in longitude (**Lo**−**LoS**), and multiply **b** by the difference in latitude (**L**−**LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

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UNITRON 4″ equatorial. Loaded with extras. Like new. Trade for de luxe Questar. L. L. Hall, 7101 Knowlton Pl., Los Angeles 45, Calif.

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SIDEREAL DRIVE for telescope, track stars accurately, simple gearless design, plans, $1.00. "Space Chart," planets, sun, moon, asteroids, constellation maps, $1.00. L. Mussgnug, Box 74, Bethel, Conn.

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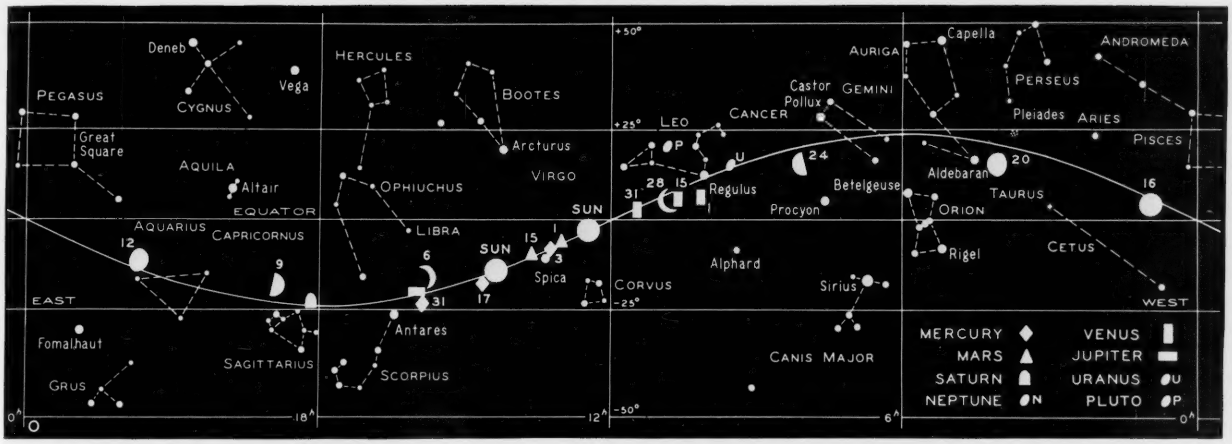

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0^h Universal time on the respective dates.

The sun will be totally eclipsed on October 2nd along a path starting in Massachusetts, crossing the Atlantic Ocean, the Canary Islands, Africa, and ending in the Indian Ocean. Maximum duration of totality, 182 seconds, will occur in French West Africa about 250 miles northeast of Timbuktu. Further details may be found on page 200 of the February, 1959, issue.

Mercury is in the evening sky, but remains too near the sun to be seen until the end of the month. By the 31st it sets about an hour later than the sun, and will be visible low in the southwest. However, this is an unfavorable elongation.

Venus, which rises about 3½ hours before the sun on the 15th, shines brightly in the morning sky all month. Greatest brilliancy occurs on the 8th, when the planet, of magnitude −4.3, is located south of Regulus near the Leo-Sextans border. Telescopically it is a thin crescent, 27-per-cent illuminated and 38″.8 in diameter. The moon will be close to Venus on the morning of the 28th. Conjunction will occur at 13:40 Universal time with Venus 0° 55′ north, as seen from the center of the earth. An occultation will be visible from South America.

Mars, in conjunction with the sun on the 30th, will not be visible this month.

Jupiter can be seen as a golden yellow object of magnitude −1.4 near the Libra-Scorpius border, setting in the southwest about two hours after the sun by midmonth. Through a telescope the planet shows a slightly elliptical disk, with a polar diameter of 30″.4 and an equatorial of 32″.5. The moon passes about 4° north of Jupiter on the evening of October 5th.

Saturn crosses the meridian about 45 minutes before sunset in the middle of the month, and remains visible in Sagittarius during the early evening hours. In a telescope, this +0.8-magnitude planet has a disk 14″.4 in polar diameter, while the maximum extent of the ring system is 36″.3. On the night of October 7-8, Saturn will be in conjunction with the moon, which will pass 4° 35′ north of the planet as viewed geocentrically.

Uranus, of the 6th magnitude, is in western Leo. Located on the 15th at right ascension 9^h $30^m.9$, declination +15° 26′ (1950 co-ordinates), this planet rises after midnight and is well placed for observation in the east at dawn. A small greenish disk 3″.6 in diameter can be seen through a fair-sized telescope.

Neptune is too near the sun for observation during most of the month, reaching conjunction with it on the 30th.

W. H. G.

MOON PHASES AND DISTANCE

New moon	October 2, 12:31
First quarter	October 9, 4:22
Full moon	October 16, 15:58
Last quarter	October 24, 20:22
New moon	October 31, 22:41
First quarter	November 7, 13:23

October	Distance	Diameter
Perigee 4, 21^h	226,000 mi.	32′ 52″
Apogee 20, 19^h	252,100 mi.	29′ 27″
November		
Perigee 2, 1^h	223,100 mi.	33′ 17″

VARIABLE STAR MAXIMA

October 3, V Canum Venaticorum, 131546, 7.1; 5, RU Sagittarii, 195**142**, 7.2; 15, R Ursae Majoris, 103769, 7.6; 16, T Cephei, 210868, 5.8; 27, S Canis Minoris, 072708, 7.5; 31, RT Sagittarii, 201**139**, 7.9.

November 2, S Carinae, 100**661**, 5.7; 4, T Normae, 153**654**, 7.4; 7, RS Librae, 151**822**, 7.7; 7, RS Cygni, 200938, 7.4.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

MINIMA OF ALGOL

October 3, 1:05; 5, 21:53; 8, 18:42; 11, 15:31; 14, 12:19; 17, 9:08; 20, 5:57; 23, 2:46; 25, 23:35; 28, 20:23; 31, 17:12.

November 3, 14:01; 6, 10:50; 9, 7:38.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

UNIVERSAL TIME (UT)

TIMES used in Celestial Calendar are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. To obtain daylight saving time subtract 4, 5, 6, or 7 hours, respectively. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown. For example, 6:15 UT on the 15th of the month corresponds to 1:15 a.m. EST on the 15th, and to 10:15 p.m. PST on the 14th.

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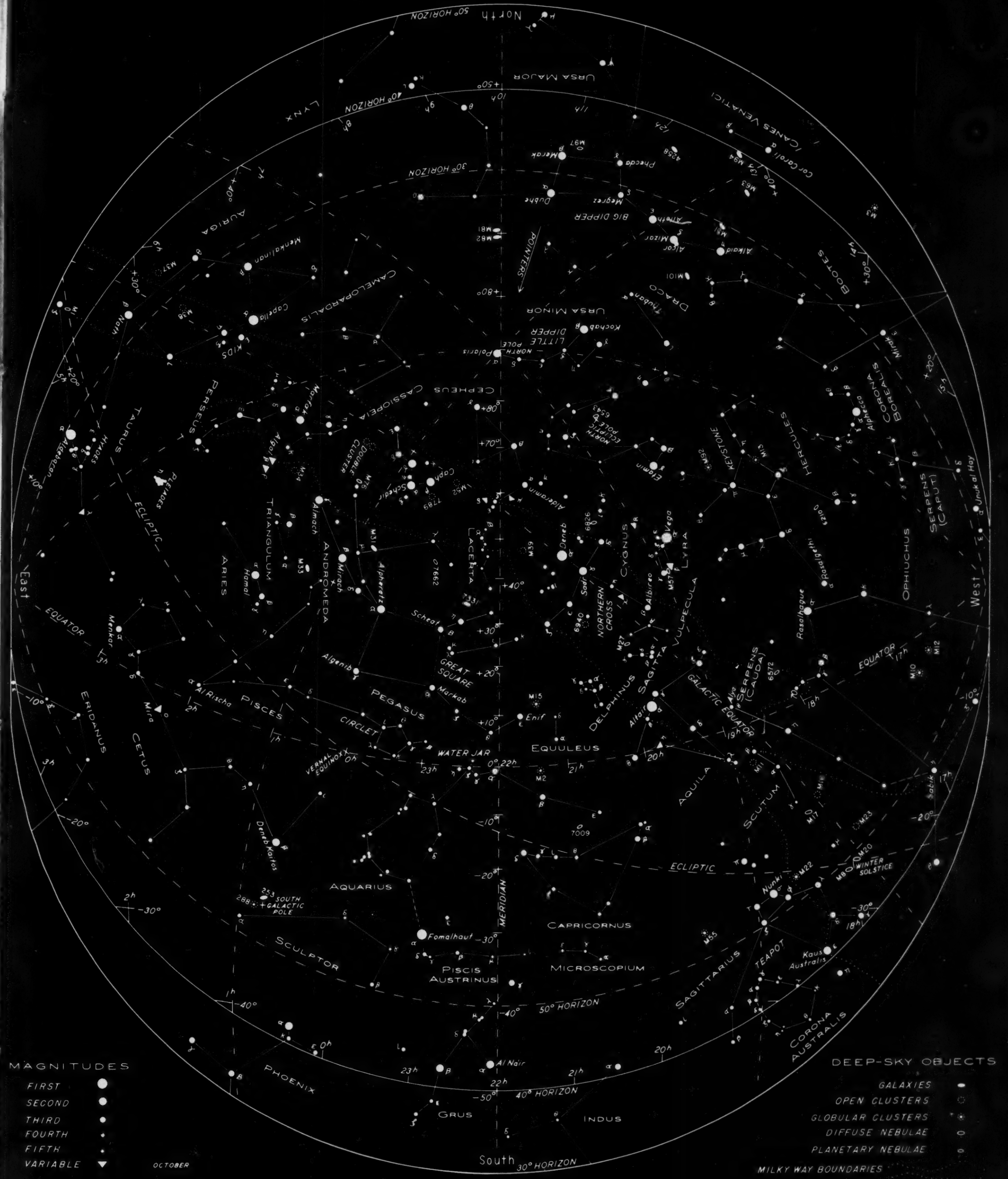
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DRACO
Thuban
URSA MINOR
Kochab
LITTLE DIPPER
NORTH POLE
Polaris
CAMELOPARDALIS
AURIGA
Menkalinan
Capella
KIDS
CEPHEUS
CASSIOPEIA
PERSEUS
Mirfak
Algol
TAURUS
HYADES
Aldebaran
PLEIADES
ECLIPTIC
TRIANGULUM
ARIES
Hamal
ANDROMEDA
Almach
Mirach
Alpheratz
DOUBLE CLUSTER
Schedar
Caph
LACERTA
Alderamin
NORTH ECLIPTIC POLE
Eltanin
KEYSTONE
HERCULES
CORONA BOREALIS
Alphecca
Mirak
SERPENS (CAPUT)
Unuk al Hay
OPHIUCHUS
Rasalgethi
Rasalhague
West
CYGNUS
Deneb
Sadr
Albireo
NORTHERN CROSS
LYRA
Vega
VULPECULA
SAGITTA
DELPHINUS
Altair
AQUILA
GALACTIC EQUATOR
SERPENS (CAUDA)
SCUTUM
Sabik
East
EQUATOR
Menkar
Mira
CETUS
ERIDANUS
PISCES
Al Rischa
CIRCLET
PEGASUS
Algenib
GREAT SQUARE
Scheat
Markab
Enif
EQUULEUS
WATER JAR
VERNAL EQUINOX
AQUARIUS
Deneb Kaitos
SOUTH GALACTIC POLE
SCULPTOR
Fomalhaut
PISCIS AUSTRINUS
MERIDIAN
CAPRICORNUS
MICROSCOPIUM
SAGITTARIUS
TEAPOT
Nunki
Kaus Australis
WINTER SOLSTICE
CORONA AUSTRALIS
PHOENIX
Al Nair
GRUS
INDUS
40° HORIZON
South
30° HORIZON
MAGNITUDES
FIRST
SECOND
THIRD
FOURTH
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VARIABLE
OCTOBER
DEEP-SKY OBJECTS
GALAXIES
OPEN CLUSTERS
GLOBULAR CLUSTERS
DIFFUSE NEBULAE
PLANETARY NEBULAE
MILKY WAY BOUNDARIES

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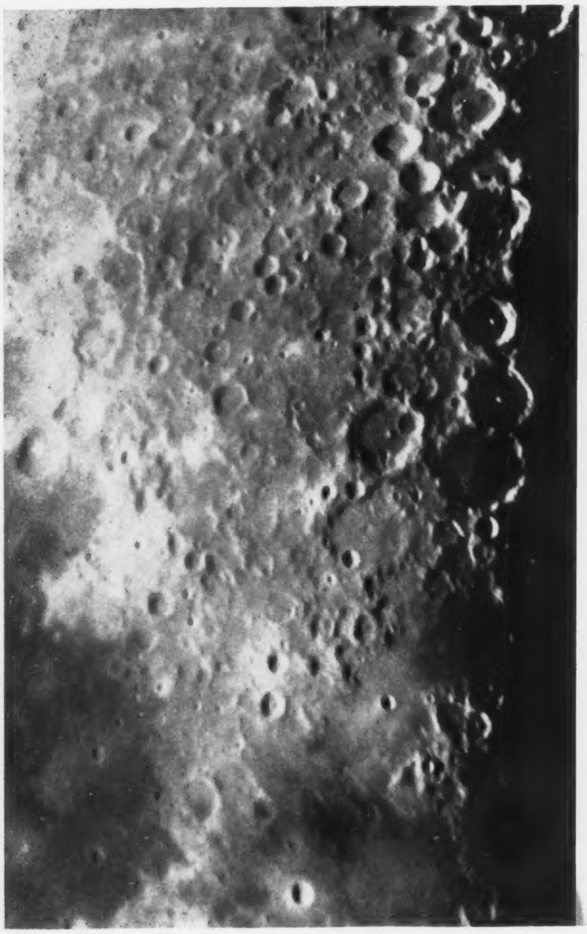
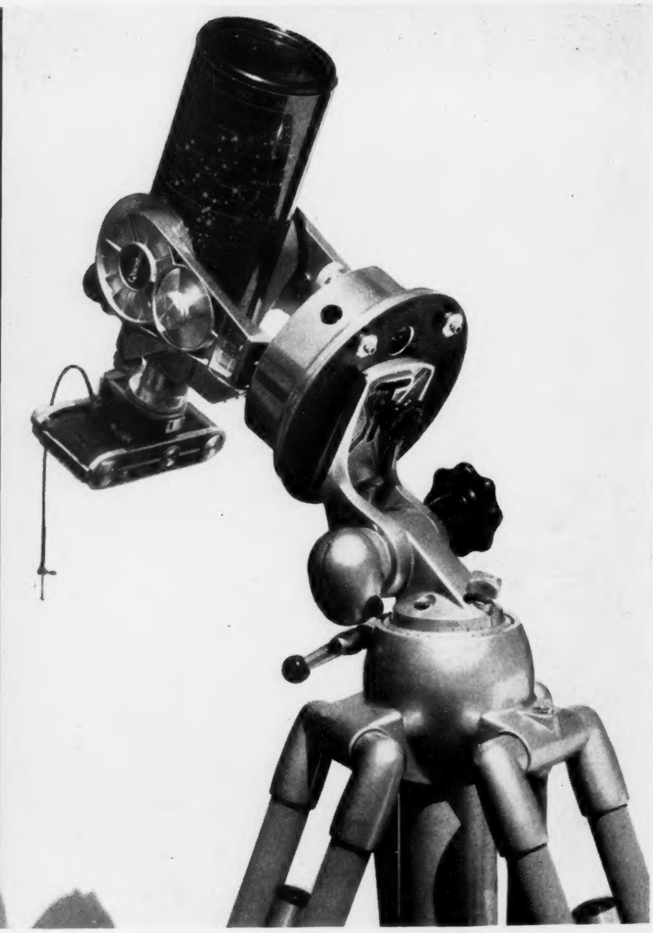
STARS FOR OCTOBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 22nd of October, respectively; also, at 7 p.m. and 6 p.m. on November 7th and 22nd. For other dates, add or subtract ½ hour per week.

Some amateurs have difficulty identifying the stars of Cepheus, a circumpolar constellation that straddles the meridian at chart time. One corner of the five-sided figure changes in appearance with the brightness fluctuations of the famous variable, Delta Cephei.





"About a month ago an astronomical group had a number of telescopes set up for a public viewing of the moon and planets. There were several refractors of 4 and 5 inches and a 12-1/2-inch reflector. I looked through them all and then set up my Questar. I was very pleased with what I saw. None of the other instruments seemed to produce the image my Questar did. I am very pleased with its performance, and I am sure no other telescope is so easy to carry and set up and use."

— S. Paul Jones, Louisville, Kentucky

It is very pleasant to receive a phone call from a Questar owner several hundred miles distant who says nice things like this about our product. It happens, however, with a frequency we find most gratifying. On this agreeable occasion last June we made bold to ask Mr. Jones if we could quote him in some way, to which he replied that he would put it in writing at once, and would be most pleased to have us use it as a signed testimonial.

That is how this ad commenced. Mr. Jones became a Questar owner early this year, and very quickly found himself taking excellent pictures, like the one above of the central portion of the moon. The exposure was 4 seconds, on 35-mm. Panatomic film, developed in Ethol. An inexpensive Praktica camera body was used, with eyepiece projection by our standard dual-purpose coupling which permits great increases in either photographic focal length or visual power. This coupling is shown on page 26 of the Questar booklet.

At right is Questar, with a Hexacon camera, attached to a black-anodized auxiliary base plate, which is, in turn, supported by the new Linhof Heavy Duty Pro Tripod and Deluxe Pan Head. This is the wonderful new tripod about which we are so enthusiastic, for it is the first one we can endorse wholeheartedly. Old friends will recall our reservations about the stiffness of the previous Linhof tripod when fully extended. This one is adequately steady at all heights, looks as though it were made for Questar, and costs only $139.50, which is $30 less than its predecessor. Weighs only 17 pounds, has new quick leg adjustments, removable braces, and folds to only 36 inches. Big rubber tips screw down to keep the leg spikes from hurting people, floors, or cars.

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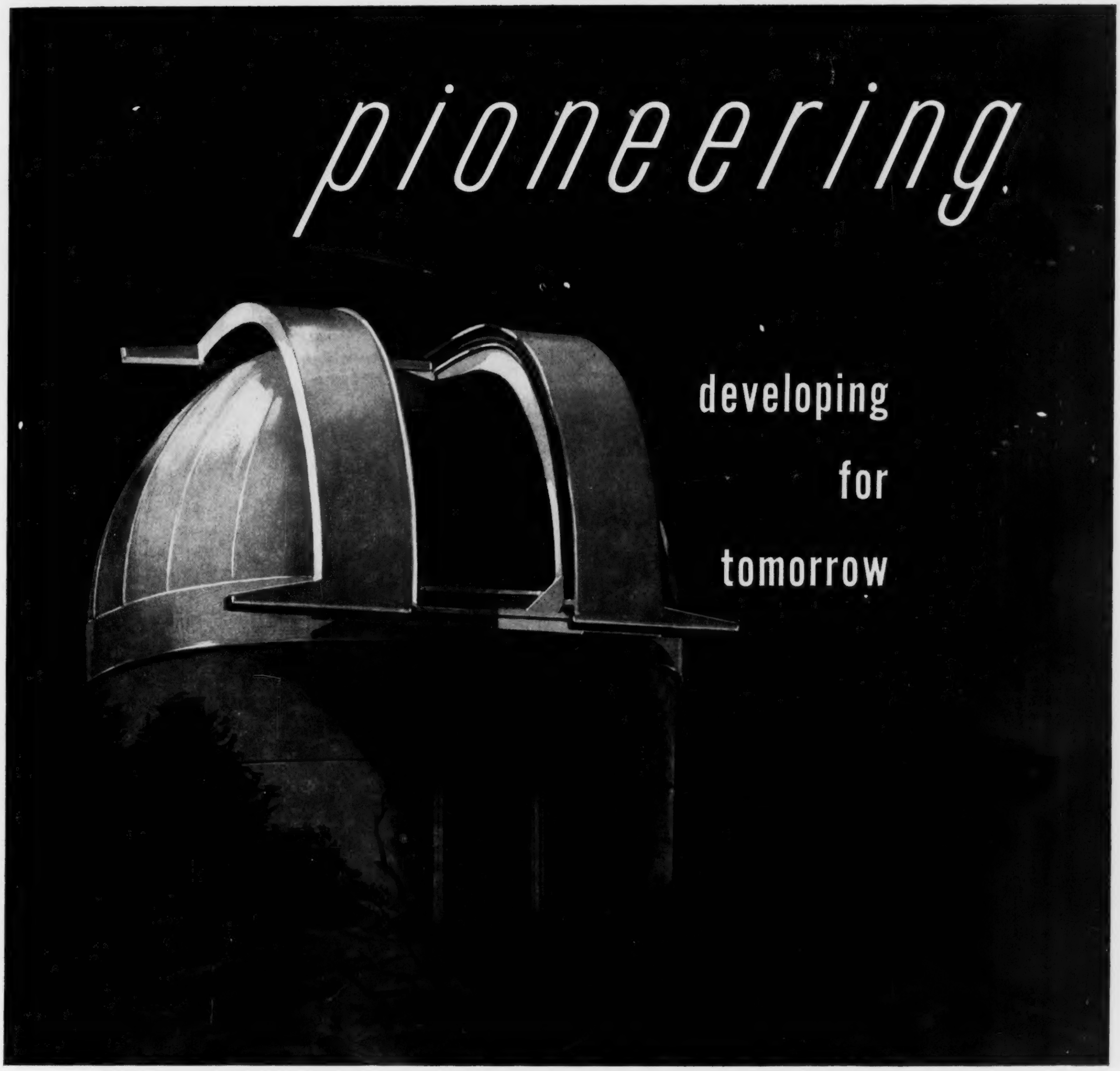

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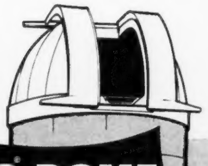

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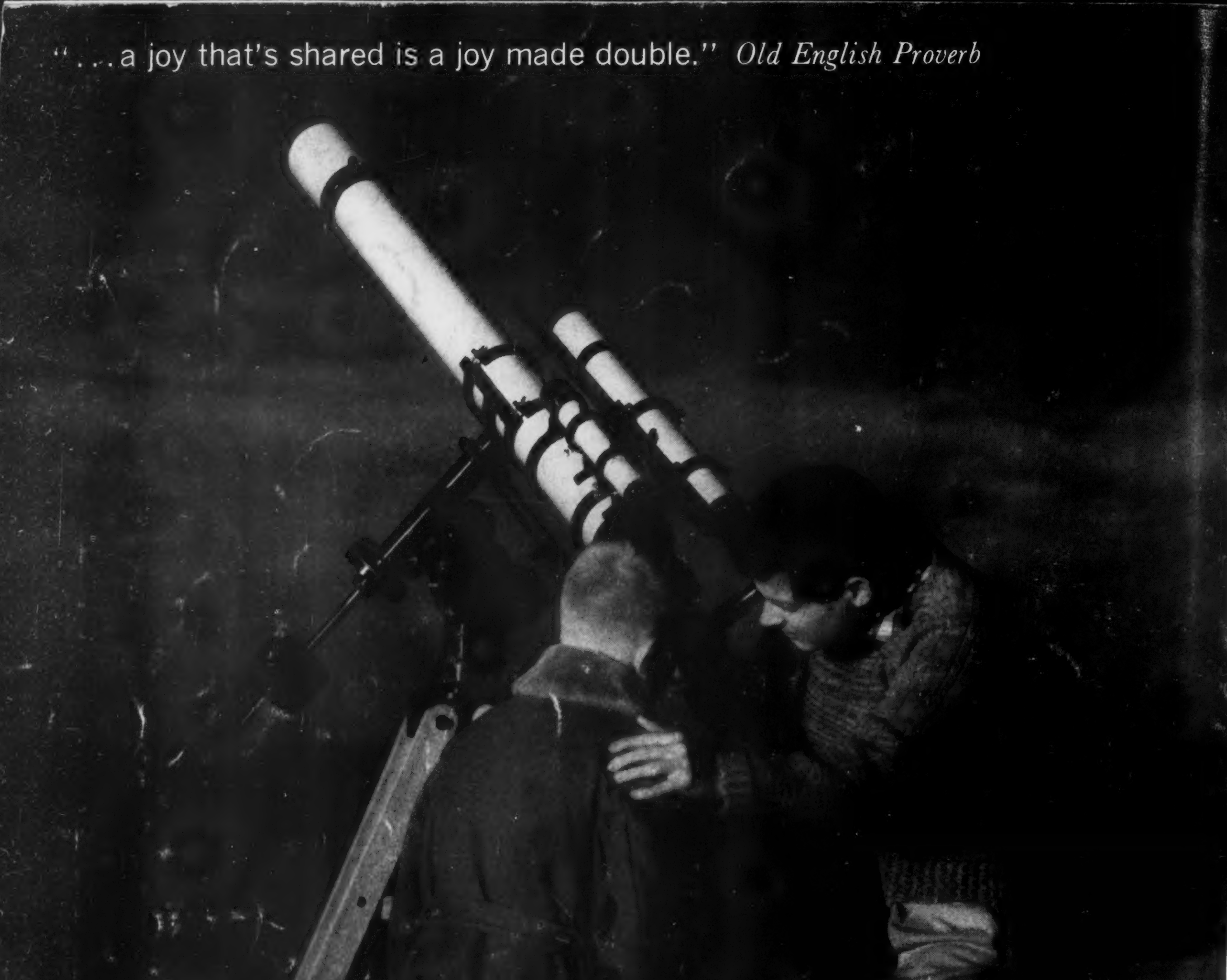

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Sky and TELESCOPE

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